

INTEL® VISUAL Adrenaline

ISSUE 8, 2011



2nd Generation Intel® Core™ Processor Family Visibly Smart

Understanding the New Intel® Core™ Processors

STREAMLINING VIDEO PRODUCTION
WITH THE INTEL® MEDIA SDK


Software

A Behind the Scenes Look at
EA Black Box's *Need for Speed® World*

FROM THE MANAGING EDITOR'S DESK

STEVE PITZEL

It's my great pleasure to serve as guest editor for this issue of *Visual Adrenaline*. As a recovering animator and session vocalist, I'm currently a marketing manager for Media and Digital Content Creation in the Intel® Software and Services Group. I've been helping behind the scenes since this magazine launched, but it's always fun to sit in the driver's seat for an issue, and I'm sure you'll find this one is packed with great information.

Behind everything is the excitement over the upcoming release of the 2nd Generation Intel® Core™ processor family (formerly code-named Sandy Bridge). This new architecture offers quite a few great things, especially for those who create digital content like videos and music.

In this issue, we'll talk to Douglas Spotted Eagle, an amazing video editor, and well-known editing tools instructor. We'll also drop in on Avid and Corel; those guys are really finding ways of making video editing simpler, easier, and faster. We'll also explore how tools, such as the Intel® Media SDK, make it easier to take advantage of not only this architecture—but even future ones!

As far as music goes—it really wasn't that long ago that all you used a PC for was to sync up your outboard gear with your tape deck—forget about recording straight to your hard drive. Now everything—recording, mixing, even instrument sounds and effects—is happening on the PC, and the more powerful and efficient the PC, the more tracks and effects you can create in real time. The architecture of the 2nd Generation Intel Core processor puts a truly mobile digital audio workstation (DAW) in the hands of consumers with better performance, longer battery life, less power consumption, and more energy savings.

It's been nice for me to step back and see how it's all coming together to make cool products that work for everyone. But enough of my yappin'—check out this issue for yourself! ■

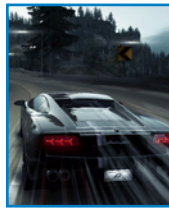


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2nd Generation Intel® Core™ processors bring quality video editing home, inspiring the moviemaker in each of us.

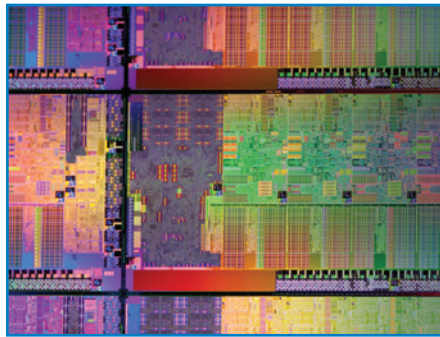
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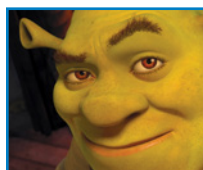
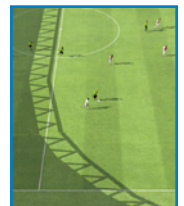


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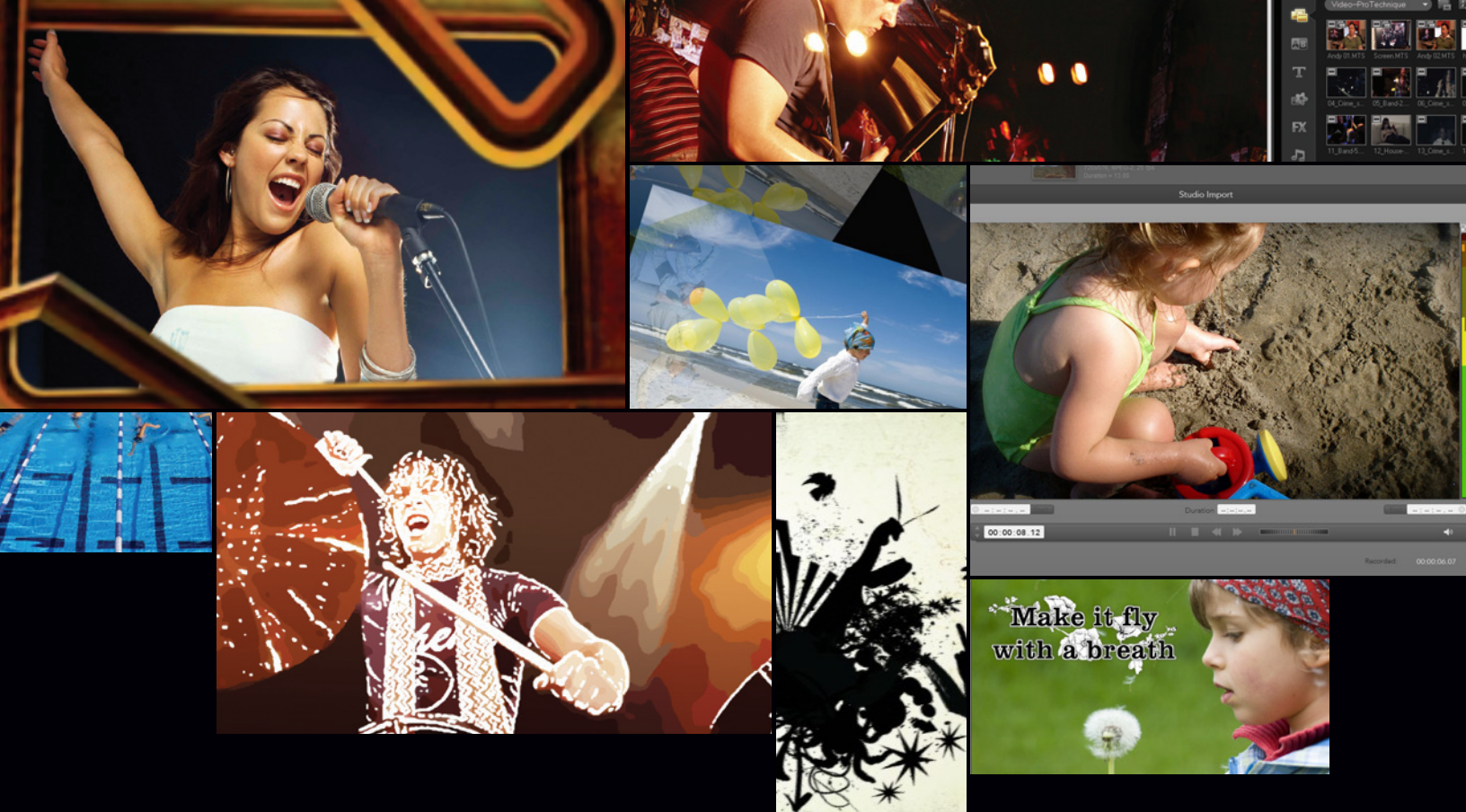
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See how everyone's favorite ogre pushes the limits of Intel's processing power with every new movie release.



THE CONSUMER VIDEO-EDITING REVOLUTION

Intel® multi-core processors and streamlined workflows bring HD video editing home

The line between consumer and professional content-creation tools continues to blur thanks to advances in processor, storage, and video technologies. Today's video and still cameras, cell phones, and computers all let you shoot and store video digitally. User-friendly consumer video-editing software such as Avid's Pinnacle Studio* family of products and Corel VideoStudio* make it easy for anyone to create great-looking HD movies, complete with Hollywood-style transitions, effects, sound, and animation, at home using off-the-shelf PCs equipped with Intel® Core™ processors.

Avid's Pinnacle Studio product line consists of Studio HD, Studio Ultimate, and Studio Ultimate Collection. Building on Studio HD as a foundation, Studio Ultimate and Ultimate Collection provide additional functionality through plug-ins by Red Giant. These plug-ins enable users to create advanced effects typically associated with Hollywood productions, such as video with a

cartoon look, lens flares, special film looks that recreate popular visual styles, and more. With release 14, the Studio line is even more user friendly, thanks to a newly designed drag-and-drop user interface. And because Avid engineers have been collaborating closely with Intel to tune and optimize their code to take advantage of all that Intel® processors have to offer, Studio products are more responsive than ever, whether they're run on

an Intel® Core™2 Duo processor or on an Intel Core™ i7 processor Extreme Edition.

**"THE 2ND GENERATION
INTEL® CORE™
PROCESSOR IS GIVING
US AN AMAZING
OPPORTUNITY
TO THROW OUT
EVERYONE'S
EXPECTATIONS OF
VIDEO EDITING."**

— Jan Piros, Product Manager,
Corel VideoStudio Pro

Corel VideoStudio Pro X3 enables enthusiasts to create professional-looking productions in a simplified and streamlined environment that combines



video editing, media authoring, and real-time effects, as well as DVD and Blu-ray* burning. Other features include:

- Professionally designed project templates by RevoStock to help jump-start productions.
- NewBlue*FX filters to easily add advanced, keyframeable effects. For example, RotoSketch turns video segments or stills into simulated drawings.
- New multi-track overlay effects and enhanced title effects to merge graphics and video content.
- A Mood Mapping music tool from SmartSound to match the style and mood of a project's soundtrack and video.

And thanks to optimization for high-powered Intel® processors, including the Intel® Core™ i7 processor, Corel VideoStudio Pro X3 performs many common tasks more than twice as fast as the previous version. With 2nd Generation Intel® Core™ processors (formerly code-named Sandy Bridge), it will be even faster.

Storytelling in the Time of YouTube*

Informed by television and online video-sharing sites such as YouTube* and Vimeo*, consumers know that it's possible to make affordable, cool videos. Many, however, are put off by a process they perceive as being overly complicated.

Video editing is essentially a straightforward process that starts with pictures and sounds that, when arranged, tell a story. Video professionals use daunting technical terms to describe the process—preproduction, acquisition, capture, post-production, and delivery. In lay terms, preproduction simply means planning. Acquisition means taking pictures, shooting video, and recording sound. Post-production refers to the editing and arranging phase. And delivery is just what it sounds like—the finished story gets sent out to the world.

Within each phase of the video workflow, even scarier techno babble lurks:

- Video and still cameras record pictures and sound in various “codecs” and “formats” with techie names such as MPEG-4 Part 10, H.264, AVI, AAC, and AVCHD.
- The vocabulary of editing uses terms such as “transitions,” “dissolves,” and “cross-fades.”
- Title graphics use “fonts” of varying “point sizes” that can be “kerned.”
- Sound gets “normalized,” “EQ'd,” and otherwise “processed.”
- Music can be “quantized.”

The jargon is as endless as it is seemingly intimidating.

“One of the challenges,” said Jan Piros, who leads Product Management for Corel VideoStudio Pro, “is making the complexity and sophistication of what's going on under the hood invisible to

VIDEO-EDITING JARGON DECODER

AAC:

Advanced Audio Coding is an audio format used by many popular portable consumer audio devices including the Apple iPod*. AAC is the successor to the MP3 format.

AVCHD:

Advanced Video Coding High Definition is a video recording format compatible with Blu-ray* Disc and used by Sony, Panasonic, Canon, and JVC camcorders.

AVI:

Audio Video Interleave is a format that can hold both audio and video information.

Codec:

A combination of the two words that describe its function: “COmpression” and “DECompression.”

Cross-dissolve:

A common type of transition in which the tail end of one clip fades out (turns invisible), revealing the next clip as it fades in.

Cut:

The most basic transition where one clip or scene abruptly ends and the next begins.

Dissolve:

A transition in which one scene fades out to reveal the next.

DV:

A standard definition digital video recording format.

Effects:

Filters and other processes that change the appearance or sonic characteristics of content.

EQ:

Equalization, a process that lets you adjust the highs, lows, and mid-range frequencies that affect the tonal characteristics of a sound.

H.264:

A scalable video codec also known as AVC (Advanced Video Coding) and MPEG-4 Part 10.

HDV:

A high-definition video-recording format that uses MPEG-2 compression to fit HD content onto the same DV or MiniDV tapes originally developed for standard definition recording.

Keyframing:

A technique used to record animation and effects in which a single frame (for example, a keyframe) defines the starting and ending point of any smooth transition.

Lens flare:

An optical phenomenon that occurs when a glass lens is pointed at a bright light source.

Normalize:

An audio process that adjusts the relative volume of a sound recording.

Quantize:

A process that aligns frequencies or beats to a precise setting. Used to correct out-of-tune singers or offbeat rhythm.

Transition:

What happens between clips or scenes in a video or film.

users. Modern camcorders, point-and-shoot still cameras, and DSLRs give people the ability to shoot very high-quality HD video, but many consumers don't understand the nuances of all the different formats. Our goal is to streamline the workflow, so people can start being creative immediately."

Bringing media—pictures, video, sound, music—into consumer video-editing software typically involves one of two processes: capture or import. Capturing video involves connecting a device such as a video camera to a piece

additional hardware. But consumer video-editing software's real power comes from support for new, so-called "file-based" formats that store video digitally. Cell phones and other mobile devices, digital still and video cameras, and webcams are all examples of devices that support file-based video recording.

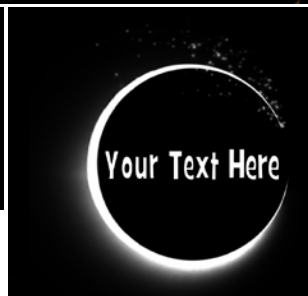
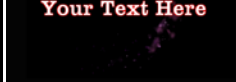
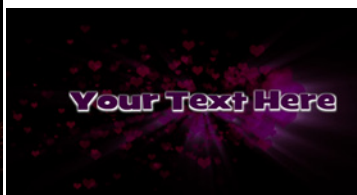
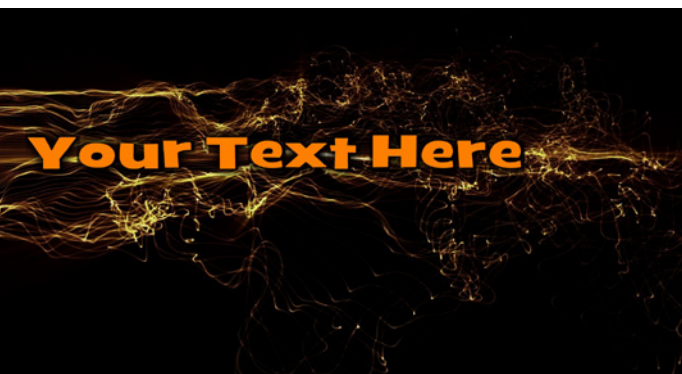
Drag-and-drop interfaces let users grab photos, video, music, and sound and bring them into their editing project. From there, wizards walk users through the editing process by automating tasks that would otherwise be time consuming.

footage that were shot, for example, when the camera was pointing at the floor.

Similarly, in Corel VideoStudio Pro, serious enthusiasts can use Express Edit mode to quickly create a "rough cut" (or preliminary version) that can be refined later with advanced editing tools.

"WE DEVELOP SPECIFICALLY FOR INTEL® MULTI-CORE PROCESSORS, SO WE TURNED TO THE INTEL® MEDIA SDK TO HELP US GET IMPROVED PERFORMANCE AND INCREASED ENCODING QUALITY."

— Markus Duerr, Director of Product Management, Avid Pinnacle Studio



of external hardware and playing the video. The hardware box takes care of converting the video and sound into a format the computer can understand. Importing video and sound simply means moving a digital file from whatever device it was recorded on—say a CF memory card, a hard disk drive, or a DVD—to the computer's file system.

Both Avid's Pinnacle Studio HD and Corel VideoStudio Pro can capture video from older analog camcorders that record on VHS or 8 mm tapes and newer tape-based digital formats such as DV, HDV, and Digital8 over IEEE 1394 (Apple FireWire*) or USB connections with an assist from

Piros elaborated, "We have a template wizard that allows users to apply professional quality effects to get transitions like turning the pages of a book or to create lower-thirds graphics."

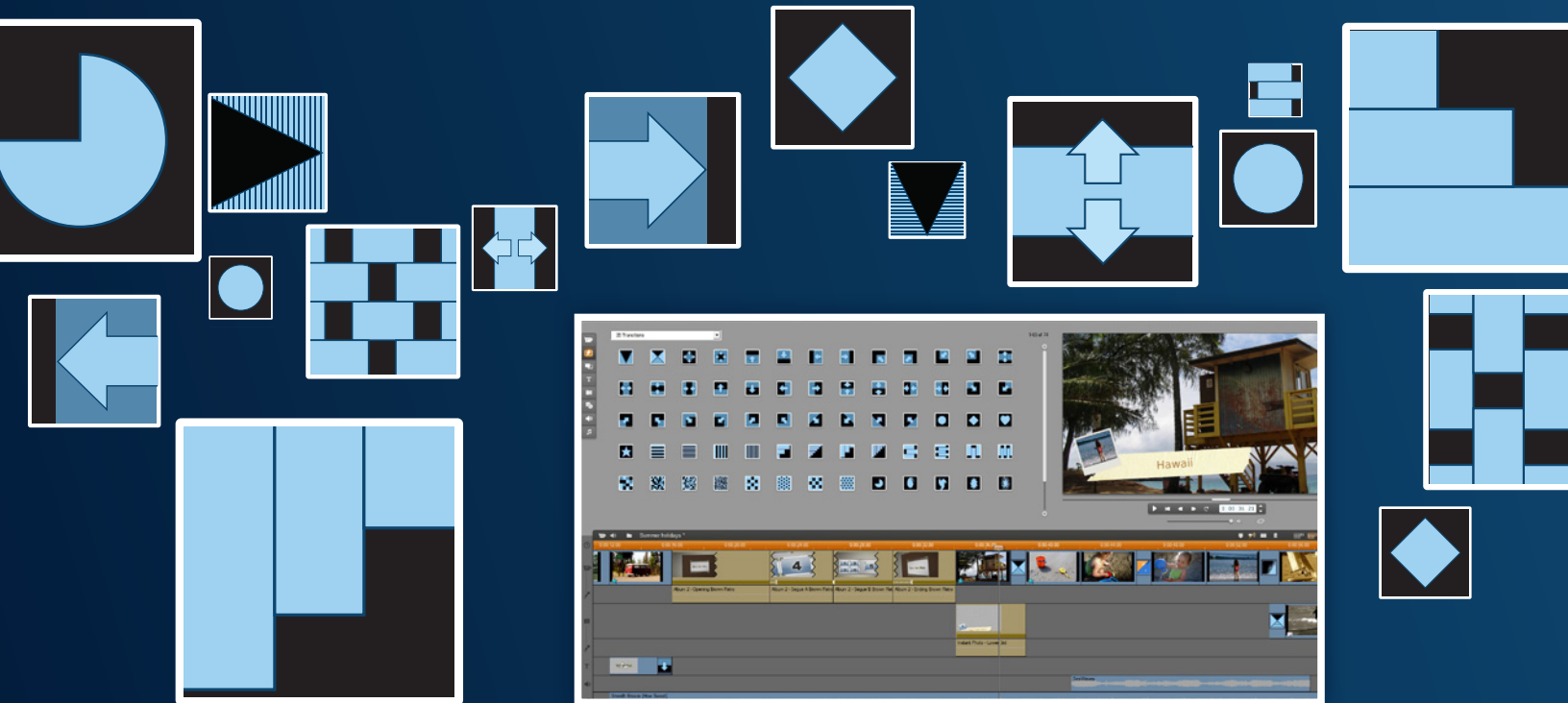
Taking ease-of-use a step further, using Smart Movie—one of the Smart Tools in Avid's Pinnacle Studio—a user can simply select footage and stills, pick a soundtrack, choose a style, and then hit a button. Studio automatically edits the video, detecting the beats of the soundtrack and cutting the video accordingly. Fast-paced music produces fast-paced video. The software actually recognizes objects in the video, so the end product focuses on scenes with people in them, eliminating portions of the

In Avid's Pinnacle Studio, prebuilt content templates called Montage Themes provide fast access to Hollywood-style transitions and animations that add professional polish to videos. In Corel VideoStudio Pro, professionally designed project templates by RevoStock can quickly turn video clips into polished movies complete with Hollywood-style titles, transitions, pans and zooms, credits, and more.

For users who like to dabble, Studio HD supports stop-motion capture so, for example, successive pictures shot with a still camera can be played back fast enough to produce home-grown animations. And to help smooth out video that is shot with handheld cameras and cell phones, Studio HD includes image stabilization technology borrowed from Avid's professional video-editing product line.

Sharing Finished Videos

Both Pinnacle Studio and Corel VideoStudio Pro make sharing finished videos easy with the ability to, for example, burn a DVD, output an



Internet-friendly file for viewing on Facebook*, upload straight to YouTube or Vimeo, or export just the soundtrack as an MP3 file.

Corel VideoStudio Pro comes with DVD MovieFactory* 7 SE for creating DVDs and Blu-ray Discs complete with Hollywood-style menus, titles, transitions, and effects. In addition, thanks to the ability to burn AVCHD-format files onto regular DVDs, users can save HD movies on DVDRs and view them from a Blu-ray player.

Today, VideoStudio Pro delivers a significant performance boost and fastest-in-class rendering times by leveraging all that Intel multi-core processors, including Intel Core i7 processors, have to offer. According to Corel, performance is what really matters to users: They want to mix and match formats freely on the timeline and still be able to play back the project smoothly. Enhanced Smart Proxy editing takes advantage of both CPU and GPU acceleration, so HD content can be edited as easily and

“HAVING A SINGLE API THAT HELPS US HANDLE LOW-LEVEL CODING FUNCTIONALITY SO WE CAN FOCUS OUR ENGINEERING EFFORTS ON DEVELOPING NEW FEATURES IS ONE OF THE BENEFITS OF THE INTEL® MEDIA SDK.” — Markus Duerr, Director of Product Management, Avid Pinnacle Studio

Stepped-up Performance

To take advantage of all this easy-to-use power, users can run Avid's Pinnacle Studio HD on legacy Intel processors, including 1.8-GHz Intel® Pentium® processors. Corel VideoStudio Pro requires a 1.8-GHz Intel® Core™ Duo processor. For best performance, especially when working with modern HD video formats such as AVCHD, Intel Core i7 processors are recommended for both the Avid Pinnacle Studio family of products and Corel VideoStudio Pro.

The entire Studio line is optimized for multi-threaded operation, so that Studio can background-render previews, computing transitions, or effects on a separate computational thread. This lets users see the results of their work in high resolution. The more powerful the system, the smoother the system's responsiveness. More powerful systems can handle full-screen, full-motion 30 frames-per-second HD previews.

smoothly as standard definition footage—even on midrange PCs—by background transcoding project footage to a lower-resolution proxy file.

Corel says that with the next version, VideoStudio Pro will support the 2nd Generation Intel Core processor, boosting performance even further, thanks to its integrated graphics capabilities, increased parallelism, and greater throughput. Effects and transitions will play in real time. The rendering process will be much faster, and the time it takes to save project files will be dramatically improved.

“The 2nd Generation Intel Core processor means one thing for video editing—raw speed. We're working on our next version of VideoStudio that's built to take advantage of all this new chip has to offer,” said Piros. ■



BAZOOKA DUCK WINS 2010 DARE TO BE DIGITAL CONTEST'S VISUAL ADRENALINE CHALLENGE AWARD

BY GARRET ROMAINE

SEVENTY-FIVE UNIVERSITY STUDENTS WORLDWIDE PARTICIPATE IN ELEVENTH ANNUAL STUDENT COMPETITION

WHAT DO YOU GET WHEN YOU BRING TOGETHER 75 GAME DEVELOPMENT CONTESTANTS IN 15 TEAMS ACROSS THREE CONTINENTS FOR 10 WEEKS? You get a terrific explosion of creative talent in one amazing competition. This year, a small duck with a big bazooka was voted as the best game by the competitors themselves and also won Intel's coveted Visual Adrenaline award. Thanks in part to Intel® tools and technology, students had the freedom to take their talents to the next level, and observers agreed that it was even more amazing than last year's phenomenal results.

Created by University of Abertay Dundee, Scotland in 1999, the annual Dare to be Digital contest targets university students interested in game development. Teams are formed with five undergraduates or recent graduates, who work together in a microcosm of a game-development company under a tight 10-week deadline to finish a functioning game prototype. Winners can expect recognition as well as job offers, depending on the quality of their finished product.

Dare to be Digital, at www.daretobedigital.com, has grown into an internationally renowned proving ground for talented computer science and art students to design their own original video game. Intel's involvement has always been strong because the company sees the importance of supporting the next generation of game software developers. Intel has been particularly interested in seeing what the students can do with the Intel® Graphics Performance Analyzers (Intel® GPA) to create games that display visual appeal and performance on Intel® HD Graphics platforms. Thus was born the Visual Adrenaline award, which goes to the team submitting the in-game sequence with the most visual appeal and best performance.

Judges measure visual appeal by considering a game's impact and by assessing the level of emotion conveyed. A game does not necessarily need complexity or realism because the judges look at the images in a manner similar to determining winners in a photo contest. Performance, on the other hand, is

Team Bazooka Duck won the Intel Visual Adrenaline Award and the Team Choice Award at the 2010 Dare To Be Digital Contest.

about making intelligent use of the Intel® Core™ processor with Intel HD Graphics hardware. Contestants must render frames efficiently and make imaginative use of resources such as textures, shaders, and render-targets. Games are not judged on CPU performance, and multi-core operation is not required.

What follows is a recap of how the student teams used Intel tools to dig down to individual frames, and sometimes to a single pixel, to troubleshoot their code. The lesson here is simple: designing, building, and preparing a game for prime time, in 10 weeks, is hard enough without adding more layers. Yet that's what Intel added with the Visual Adrenaline Challenge: reward the team that best optimized their game to run on a mainstream configuration. With the help of the Intel GPA, teams were able to easily identify the bottlenecks in their game and address them. If students on a short 10-week development schedule can create a full-blown prototype from scratch using these tools, experienced developers should expect even better results.

Nine out of fifteen teams rose to that difficult challenge successfully, showing their games running at a playable frame rate, without sacrificing the look and feel, while often implementing non-trivial rendering techniques. All praised Intel GPA for its usefulness in this particular undertaking, but also in helping them tune their games across platforms.



Bazooka Duck Rewinds Time

The winner of the Visual Adrenaline Award for 2010 was Bazooka Duck's *Epoch Defence*. Judges agreed it was visually appealing and technically impressive, running at 20 frames per second at a resolution of 1600 x 1000 pixels. The game has a level of sophistication and polish that makes it look less like a student project and more like a real title.

The premise is clever, as well. Set in a kind of "War of the Worlds" scenario, gameplay resembles a standard real-time strategy (RTS) setup, with units of various abilities fending off an invasion of aliens who pack superior firepower. The intricacy of the game multiplies, however, when you run out of units. The game "rewinds" itself, so that you start a new round alongside your old units. As the creators explained, "This time, if you target the enemy strategically, you can save many of your fallen allies from their fate, bringing them back into your control, ready to continue their role in the war effort!"

Bazooka Duck kept a sporadic blog throughout the 10-week contest, capturing some of the frantic moments in building the game. Here's a snip from an early entry:

... Chris, Joe and I have been busy building the start of an RTS engine. Using Ogre for graphics, we've got units (currently ninjas, one of the more superior varieties of placeholder graphics) which we can click on and order to run around and attack each other.

The interface is being developed by Joe; yesterday I managed to add a button to play explosion sound effects, and Chris has been experimenting with physics engines... Meanwhile, the Dans (our artists) have been hard at work creating the models for our units, which we've successfully managed to import into the game as well.

Clearly, these are serious game developers in action. Bazooka Duck's Chris Thompson reported that Intel GPA was very helpful to the team. "It told us straightaway that our main problem was the fill rate of the graphics card. It told us where we needed to focus and what to try and cut. The [Intel] GPA tools also have a library for us in our own metrics, so we could benchmark the code as well as the graphics system. We used it to work out where bottlenecks were in our rendering system and find the model limits of the graphics cards on the Intel machine."

Mark Engley, one of the programmers on the Bears with Jetpacks team, helped produce *Grrr!* It's a basic action-strategy game, and thanks to the Intel GPA, Engley was able to optimize for various machines. "We got our game to run at something like almost 30 fps on the G45, but then when we took it back to our main machines, we found that essentially we had doubled the frame rate in that case as well. Obviously, if you're releasing a game you want it to be able to run on the widest range of computers possible. [Intel] GPA did a timeline of everything



(ABOVE) The premise behind *Epoch Defence* reminds players of an older version of "War of the Worlds," set in Victorian England.

(ABOVE, RIGHT) Bazooka Duck's *Epoch Defence* appears to be a standard real-time strategy title at first, but it actually operates in four dimensions. Each new round starts alongside the previous units.

(LOWER, RIGHT) Bazooka Duck put excellent detail into their terrain, structures, and units.





"Before and after" scene from *Grrri!*, produced by the team Bears with Jetpacks. The bottom screenshot contains much more detail, after optimization with Intel® Graphics Performance Analyzers.

we're drawing on the screen: trees, background, the football, the goalkeeper, and all that. When we looked at it we saw that our trees were taking maybe ten, twenty times longer to draw than the goalkeeper or the football. We were able to just cut the number of trees we're actually using in the game in half and place them where you would see them, as opposed to on the outskirts, cutting our draw time down by a huge amount."

Engley found that the main bottleneck was the way they were making a lot of very small draw calls. The team found that the game would speed up if they could group their draw calls together. "Our floor, for example, was a load of individual squares, and we were drawing each one of those squares as a separate draw call," Engley said. "The overhead was that each draw call takes a set amount of time, and then a bit of extra time for each, however complex the object is. But these objects were so simple that it was quicker to just group them all together and do them as one big draw call, so you just get the initial overhead of the draw call, and then drawing the extra triangles in the floor actually didn't take much time at all. Just that one change improved our frame rate by something like 30 percent."

Intel GPA also provided Engley a way to select an individual pixel and determine the actual history of that pixel in the draw call.

"Sometimes you might end up writing to a pixel more than once," Engley explained, "which is generally seen as being inefficient, and so if you know you're spending a lot of time overwriting the same pixels, you might choose to draw your object in a different way that causes these pixels to only get hit once."

The Bears with Jetpacks team found that if they could speed up their graphics code, they would solve the main bottleneck in their prototype. Engley said he was "amazed" at the level of detail the Intel GPA tool provided. "You can look at each draw call and look at the space that it's actually drawing to on-screen, and you can look at groups of draw calls and break it down to the individual pixel level. This was very good for optimizing our shaders, the things that actually draw the individual pixels on-screen. It was very useful for looking at the way that we were drawing our whole scene, so it gave a good range of information and quite high-level and low-level information as well."

Jocce Marklund, team leader for That Game Studio, helped produce *Twang*, a side-scrolling racing game. The team had a very positive experience with the Intel GPA tool. "We had a really rough shader, so it drained all our power from the computer and we wondered why," he recalled. "We used the [Intel] GPA to locate and fix the problems. The tool has really helped us a lot with just optimizing the game."

David Clarke, programmer on team eleMENTAL, was one of the creators of *Weatherman*, a 2.5D puzzle platformer, where the player solves puzzles using the weather and progresses through the game to find the missing pieces of his plane. Clarke and his team used Intel GPA to view performance statistics, such as how fast the game was running, how many draw calls they were making, and where the game was over-performing. "You could really see where you were doing things more efficiently," Clarke said, "and you could see where you might tune it and tweak it to make it run better."

An Iterative Process

Andrew Glass, programmer for team Shark on a Bike, said Intel GPA was crucial to their success. "The software lets you look at what's going on in the frame and helps you decide what you can change to make the frame go faster, so that your game will appear smoother and will actually be a bit more playable on certain machines. You look at another thing, do it again, then look at another thing, and this time maybe something else is bigger because the thing you made small was dominating the frame. When you get rid of that, you see a whole bunch of other things pop up, and it's kind of like an iterative process. Eventually, you get to the point where you don't need to change anything and it runs fast enough."

Daniel Leaver, programmer for *Silent Symphony*, was part of team Creative Genius. Their game consists of a character who

sees sound as color and uses a flute to make sounds that result in a cloud, which then interacts with the rest of the environment. Intel GPA helped them identify where the game was drawing clouds that weren't actually needed. "The Intel software enabled us to see that we were drawing the clouds unnecessarily, which was taking up time and the reason why the game was running slow. Once we corrected that we gained about 5 frames per second. We went from 25 FPS to 30 on a slow computer."

Team Gazhab created *Chayya*, a racing game in a black-and-white urban environment. The goal is to avoid red lights, which kill you, and look for green lights, which speed you up and get you back to your ship faster. According to Murray Speight, lead programmer, Intel GPA came in handy for getting down to individual frames. "It allows you to capture a frame of your game, maybe a bit which

you find [too] slow. So you can see exactly what has taken up all the resources of the processor [and] the graphics card. We've actually taken a couple of frames in different areas of the game and we've seen that some things were getting drawn more than others, and some things have got higher poly's in the game than they should really have."



Scene from *Dyed World*, produced by team Shark on a Bike.

The Big Finish: Dare ProtoPlay

The final part of the competition is Dare ProtoPlay, where awards are announced and all games are on display. In addition to the Visual Adrenaline Award, the three overall winning teams were announced: Angry Mango, Team Tickle, and That Game Studio. These teams were also the sole nominees for the British Academy of Film and Television Arts (BAFTA) Ones to Watch award, chosen by a panel of gaming industry experts during the three-day event.

Clearly, the young students have come a long way in 10 weeks, networking like crazy, learning new tricks, and adopting new tools. The contestants have their prototypes, but things won't end there. Every participant will have great resume fodder and a crown jewel for their portfolio. Imagine how valuable it is to be able to talk about your first-hand experience with all phases of game development when being interviewed for your first job. That confidence with leading tools and advanced processors is part of what makes it all worthwhile for Intel, and what makes the future of gaming look so bright. ■

ABOUT THE AUTHOR

Garret Romaine is a senior writer, working for *Rose & Her Minions* from Beaverton, Oregon. Garret started in gaming as a beta tester for Epic MegaGames and has been a columnist, editor, and reviewer ever since. Garret is a Fellow in the Society for Technical Communication and teaches technical writing at Portland State University.

Teams That Participated in the 2010 Dare to Be Digital Contest

TEAM	GAME	PREMISE
Abnormal Creations	<i>The Inkwell Chronicles</i>	2.5D puzzle/adventure PC game
Angry Mango	<i>Mush</i>	Microsoft Windows* 7 phone 2D platform puzzler
Bazooka Duck	<i>Epoch Defence</i>	Time-based tactics game
Bears with Jetpacks	<i>Grrr!</i>	Multi-player real-time strategy for Wii*
Creative Genius	<i>Silent Symphony</i>	2.5D puzzle game
eleMENTAL	<i>Weatherman</i>	3D platformer PC game
Gazhab	<i>Chayya</i>	Third-person stealth platformer
Grimnir Games	<i>Death Inc.</i>	2.5D side-scrolling platformer
King of Dice	<i>Dice Rolling</i>	3D puzzle game
Nevermind Games	<i>WiiKick</i>	Multiplayer football party
Ramblin' Wreckage	<i>Hella Umbrella</i>	Android* phone puzzler
Shark on a Bike	<i>Dyed World</i>	2.5D adventure/puzzle
Team Tickle	<i>Sculpty</i>	Physics-based platform for Apple iPad*
That Game Studio	<i>Twang</i>	Side-scrolling racing game
Various Artists	<i>Legendary Crusaders</i>	Puzzle

ROLLING THUNDER, ANALYTICS, AND PERFORMANCE DRIVE *NEED FOR SPEED** WORLD

NEW ONLINE RACING GAME
JUMPS QUICKLY TO THREE
MILLION PLAYERS

*Need for Speed** World, built by Electronic Arts (EA) Black Box in Burnaby, British Columbia, started a little more than two years ago with a simple idea: become the first real racing MMO. Racing games developed earlier in the MMO era have tended to appeal to only true car enthusiasts.

But EA wanted to take the car culture to a more casual audience, knowing that racing gamers don't need to understand the ins and outs of how a car works in order to enjoy zipping along online city streets or a race circuit at high speed.

This free-to-play, graphically-rich online game has over three million players; is continuously refreshed with new features, modes, cars, and an expanding world; and is already optimized for play on the 2nd Generation Intel® Core™ i5 processors. Whether you drive a laptop or a desktop, massively multi-player racing has never felt so good. To get in on the racing action, download the game for free at:

<http://world.needforspeed.com/>.



Visual Adrenaline recently caught up with two of the key visionaries behind *Need for Speed World* and got a glimpse behind the scenes. Dave Wall, a 15-year veteran of the gaming industry, is the rendering and systems lead and has been working for more than three years on the *Need for Speed* franchise for EA. Eneko Bilbao, Black Box's technical director, is a long-time technical strategist for racing games in Europe and has worked on *Need for Speed* for two years. Together, Wall and Bilbao provide a convincing case for using Agile development, in-game analytics, and Intel® tools for creating a rolling-thunder rollout of new game features and optimized game performance.

The Development Team Goes Agile

Before its MMO incarnation, *Need for Speed* was released every year by Black Box from its offices in Vancouver, B.C. Because such a pace was unsustainable, execs decided to share the NFS franchise across multiple studios. Gone were the lengthy periods of intense crunch time to get the game released every year. Also, the team switched to an Agile development process and started churning out smaller, more frequent updates. “Now we’re releasing a patch every week,” Wall explained. “The way we used to do games just isn’t sustainable for this type of game, so it’s been something we had to change.”

Pivoting from the old days of long projects with a big push at the end by all the team members just prior to code release, the culture of the development team is now about learning and reacting quickly. The team has replaced brute force and long hours with being very smart and quick to react to challenges faced by their players. “Because we are creating a game as a

gamers seem to enjoy and use that data to speed adoption of new features and modes. These analytics allow the development team to almost instantly gain “telemetry” on how the gamers are using a new feature and the rate at which it is being adopted.

“Initially,” said Bilbao, “we didn’t know exactly what data we were after—so we captured maybe too much data. But now we are optimizing it to make sure we get what’s relevant.”

“When we release a new racing circuit, or a new area in the city, we can track whether the gamers are using the circuit or going to that new area,” Wall noted. “We can see if they are having difficulties and get a lot of immediate feedback on what’s happening there. Not everything we release is immediately adopted by our gamers; we’ve seen some features or gameplay that the players aren’t happy with just by reviewing our analytics.” When that happens, the team can decide whether they need to change anything or whether they need to spend their resources on a new feature that’s already in the pipeline, but scheduled farther in the future.

Having instant access to such a treasure trove of information is a developer’s dream. The game’s pricing model is based on the levels being free, but after that, everything is microtransaction-based. The analytics help the game developers understand what people are buying, why they are buying it, what they were doing before their purchase, and much more.

service, we have been extremely careful to manage overtime—and actually try not to have any—because the game is never stopping. Today we work at a level pace, which not only is better for our developers, but allows us to constantly improve the game for our players,” said Wall.

With today’s weekly maintenance routine, *Need for Speed World* is rolling out live patches and feature updates like a well-oiled machine. Some of the recently released features include new car models, car customization, and a completely new night time mode, where all the cars are lit with headlights and new special effects. What’s in the hopper for the future? That’s where the developers’ use of in-game analytics comes to bear.

In-Game Analytics Substantiate Player Feedback

Need for Speed World uses a proprietary suite of in-game analytics that pinpoint exactly what the players are doing in the game at any given moment. The developers can analyze what the

EA’s Bilbao said they consider a lot of data points, with analytics being just one facet of their decision making. “In addition to our analytics, we look at the forums, and then we take that feedback and adapt. We listen to what the community really wants, so that’s why we are in this very different space from any



other game. We see what really matters, whether it's really verbalized and expressed or just brought out by data patterns from our analytics. We see how the customers enjoy playing this mode more than the other one, enjoy this race, enjoy this car, and so forth. Then we can quickly respond using our Agile development process."

Wall agreed. "We've got all licensed car models, which is a big thing for a lot of people. Each player wants to race his or her dream car." Developers found that players wanted to customize their rides, add vinyls and stickers, and then show off their work. Based on player feedback and analytics, developers also realized that even though they were producing a racing game, racers needed a place to cruise along, parade-style. So they added a photo mode, an area of the game where players don't have to race around—they can drive their car and get screenshots to share with fellow racers and friends.

The payoff has been a rise in customer satisfaction and rapid growth, even though the team is sticking closely to their original goals. "We want to be THE racing MMO," Bilbao said. "We want to be the top game for the casual, mass-market car audience." New, rich content continues to pour out of the studio. Around the time this article goes to press, a new game mode, Team Escape, will debut, opening up the complex racing action even more with a cooperative pursuit mode. And a new night time driving mode will make an appearance, showcasing additional rendering and lighting effects. And of course—the cars: more licensed cars will come online at a regular pace. The development team is also looking into 3D, alternate platforms, wide-screen settings, and new power-ups. With all those customer requests, it's good to have rock-solid data to support their decisions.

Optimized to Perform Across the PC Spectrum

The expectations are set high for the game in terms of graphics because the team actually compares themselves to the other *Need for Speed* titles. "So the bar is really high," Wall admitted. "When we look at what we are trying to achieve, when we look at the visuals, the art and game reviews are all done on high-end hardware with all the effects turned on. The challenge has been to build something scalable that still looks good when you are in medium settings."

Because the game runs on a wide range of hardware that dates back more than five years, much of the development work has focused on scalability, supporting what are essentially primitive machines all the way up to Intel® Core™ i7 processors.

"From the beginning," Bilbao said, "we were focused on the low-end machines because we wanted to make sure that it runs on business-class laptops. Initially the game was designed for

ANALYTICS HELP TUNE *NEED FOR SPEED* WORLD*

A common problem in the gaming world is the need to balance out changes, updates, and added features with the fear that the game's players may not care. Before investing huge sums of money and developer time, producers have to be confident that the work will pay off. One way to make sure is to gather extensive amounts of data from the game itself. *Need for Speed* World* produces mountains of data about the game and the way it is played in the real world, and that data stream has proven to be a wealth of information. Eneko Bilbao, EA's technical director, took some time to describe the analytics that monitor the gameplay and area usage, giving live feedback to the development team.

"The whole system is custom-built," Bilbao explained, "around established technology like Microsoft SQL Server* Integration Services and MicroStrategy* 9, allowing for the vast volume of data we need to process. We hired experts from the retail and finance industries to help us architect and build the analytics system end-to-end."

Although EA already has systems in place for gathering traditional web metrics and usage statistics, the added system takes that information flow to a new level. "We are fully compatible and integrated with the existing system," Bilbao said. "But the new analytics system was built specifically for *Need for Speed World*, as the team needed something sophisticated and scalable to deal with the volume of data coming in."

"We actually use it to tune the game," Bilbao added. "As in most MMOs, balancing the different items, skills, and events is crucial to offer a fair and fun experience. By looking at aggregated data, we see which events are the most popular and then try to understand what they have in common to drive the design of new races. Also, by looking at which cars are currently hot with our gamers, we can see which ones we should bring out next or if we need to retune some to make them on par with the other cars in the game."

"Drinking from the firehose" is a common metaphor that sums up what it's like to try to understand an overwhelming amount of data coming in quickly and continually. Bilbao is trying to sip from a shot glass instead. "Our servers process one million records per hour, which is around 8 GB of data to process daily. On modern hardware, it takes around eight hours to process and to generate all the reports we need."

The payoff for analyzing all that data is instant access to what the gamers like and want more of in the game. And that's a developer's dream. ■



the Asian market, where they have an Internet café and not necessarily the high-end computers. We want to offer the best experience ever on this class of hardware, so we zeroed in on integrated graphics, laptops, and the business machine.”

Interestingly, however, the team develops and tests the game across a wide spectrum of PCs, including the new 2nd Generation Intel® Core™ i7 processor systems, with four or eight gigabytes of RAM and running 64-bit Microsoft Windows® 7, as well as a variety of older machines, laptops, and even high-end netbooks.

Intel Tools Make a Difference

Getting that optimization correct across so many hardware possibilities would not have been easy without the help of Intel’s tools, including the Intel® Graphics Performance Analyzers (Intel® GPA) and Intel® VTune™ Performance Analyzer. For example, Wall noted that, “The Intel GPA tool helps us to understand what is

captures with Intel GPA, they were able to visualize and resolve cases where the engine was spending rendering time on surfaces or menu targets that weren’t visible to the user.

Thanks to the use of Intel® optimization tools, the work the development team did for current PCs easily translates to the 2nd Generation Intel Core processors. Wall said the work has already paid off. “We were pleasantly surprised when we got our first 2nd Generation Intel Core processor machines. Using [Intel] VTune [Performance Analyzer], we identified an entire section of the multi-player code that we could move to another thread. Once we did that, on our 2nd Generation Intel Core processor systems we’re basically GPU bound, especially on high settings. We’re pretty happy running at 60 FPS on medium settings, but we’re trying to get it a bit better on high settings. We see that we need to spend a bit of time optimizing on the GPU.”



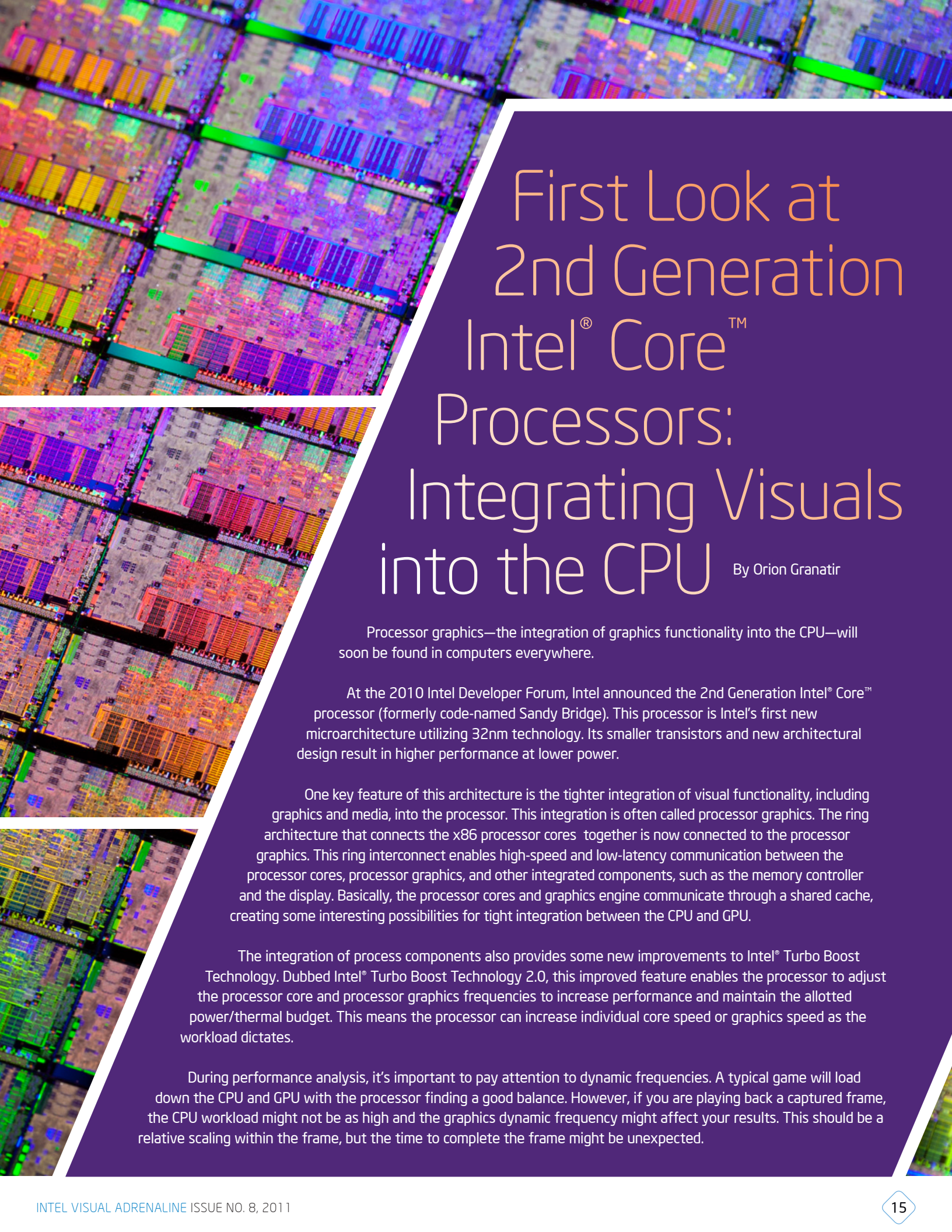
expensive on the low-end that is going to be reserved only for high-end. I think that is where it really comes in handy—understanding the different characteristics of the hardware.” The team put in a lot of work to identify and understand which effect to assign to which class of processor and then make sure that the game is perfectly balanced, depending on what it is running on. “Intel GPA is very good at telling us how long a particular effect took in terms of GPU time,” Wall explained. “That makes it easy to know exactly which effects to shut down to try and get the frame rate as high as possible.

“Intel GPA is fantastic in being able to drill down and see exactly what was done through to the hardware, allowing us to detect and locate edge cases where the game could be optimized,” Wall continued. For example, by extensively using



So even though the 2nd Generation Intel Core i5 and Core i7 processors systems weren’t on store shelves when this article was written, *Need for Speed World* will support them on Day 1. That’s one way to win a race—take the checkered flag before the starting pistol is even fired. ■

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First Look at 2nd Generation Intel® Core™ Processors: Integrating Visuals into the CPU

By Orion Granatir

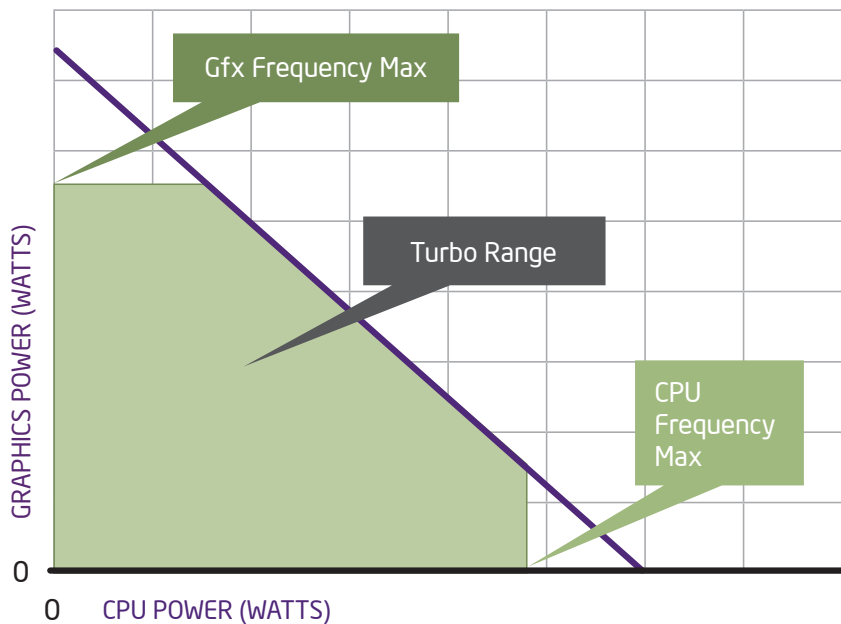
Processor graphics—the integration of graphics functionality into the CPU—will soon be found in computers everywhere.

At the 2010 Intel Developer Forum, Intel announced the 2nd Generation Intel® Core™ processor (formerly code-named Sandy Bridge). This processor is Intel's first new microarchitecture utilizing 32nm technology. Its smaller transistors and new architectural design result in higher performance at lower power.

One key feature of this architecture is the tighter integration of visual functionality, including graphics and media, into the processor. This integration is often called processor graphics. The ring architecture that connects the x86 processor cores together is now connected to the processor graphics. This ring interconnect enables high-speed and low-latency communication between the processor cores, processor graphics, and other integrated components, such as the memory controller and the display. Basically, the processor cores and graphics engine communicate through a shared cache, creating some interesting possibilities for tight integration between the CPU and GPU.

The integration of process components also provides some new improvements to Intel® Turbo Boost Technology. Dubbed Intel® Turbo Boost Technology 2.0, this improved feature enables the processor to adjust the processor core and processor graphics frequencies to increase performance and maintain the allotted power/thermal budget. This means the processor can increase individual core speed or graphics speed as the workload dictates.

During performance analysis, it's important to pay attention to dynamic frequencies. A typical game will load down the CPU and GPU with the processor finding a good balance. However, if you are playing back a captured frame, the CPU workload might not be as high and the graphics dynamic frequency might affect your results. This should be a relative scaling within the frame, but the time to complete the frame might be unexpected.



Because Intel Turbo Boost Technology 2.0 is automatically controlled by the CPU, developers cannot directly control it. However, understanding how it works is important. Most games I have investigated benefit well from the graphics dynamic frequency scaling.

The addition of Intel® Advanced Vector Extensions (Intel® AVX) is another interesting 2nd Generation Intel Core processor feature. Intel AVX extends single instruction, multiple data (SIMD) instructions from 128 bits to 256 bits. For applications that are floating-point intensive, Intel AVX enables a single instruction to work on eight floating points at a time instead of the four that the current SIMD provides. (It's important to note that other hardware vendors have also announced support for Intel AVX.¹)

Most developers will use the latest Microsoft Visual Studio* compiler or the Intel® C/C++ Compiler to take advantage of Intel AVX. But for the clock-counting, bit-shifting, tech-heads out there, you can learn more at [the Intel AVX Web site](#). (It even includes an emulator.)

The best way to work with Intel AVX is through intrinsics, which are supported by both the Microsoft and Intel® compilers. Anyone familiar with programming Streaming SIMD Extensions (SSE) or Sony PlayStation® 3's SPUs will be good "frenemies" with intrinsics. Intrinsics are compiler-specific functions that usually compile down to highly efficient inline machine instructions. Because the compiler has a strong understanding of intrinsics, it will often generate code faster than inline assembly code. Intrinsics are the best way to write high-throughput, compute-intensive code on the CPU and are an acquired taste, like wine or Remedy Entertainment's *Alan Wake*®.

Intel engineers and performance-hungry developers are already exploring the ways Intel AVX can benefit game and graphics applications. For example, my coworker, Stan Melax, just wrote [a great article](#) presenting a programming pattern to improve the performance of geometry computations by transposing packed 3D data on-the-fly.

Intel AVX is interesting, but let's shift our focus to the processor graphics engine.

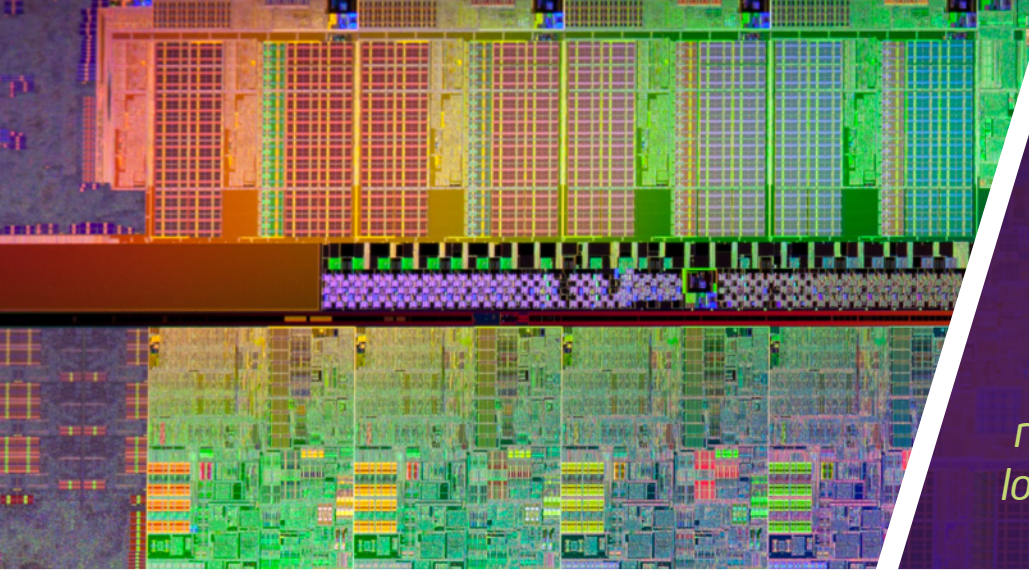
The 2nd Generation Intel Core processor family is Microsoft DirectX® (DX) 10.1 compatible. I like the DX11 multi-threaded API, so most of my current code is DX11 with the proper DX10.1 "feature level" set for 2nd Generation Intel Core processors. With full DX10.1 support, you'll encounter no major surprises when programming for Intel's processor graphics. However, you'll need to keep a few things in mind.

The memory layout for processor graphics is different than it is for a discrete card. Graphics applications often check for the amount of available free video memory early in execution. As a result of the dynamic allocation of graphics memory performed by the processor graphics (which includes Intel® HD Graphics), you need to know the total amount of memory that is truly available to the graphics device. Memory checks that supply only the amount of "local" or "dedicated" graphics memory available do not supply an appropriate value for these devices.

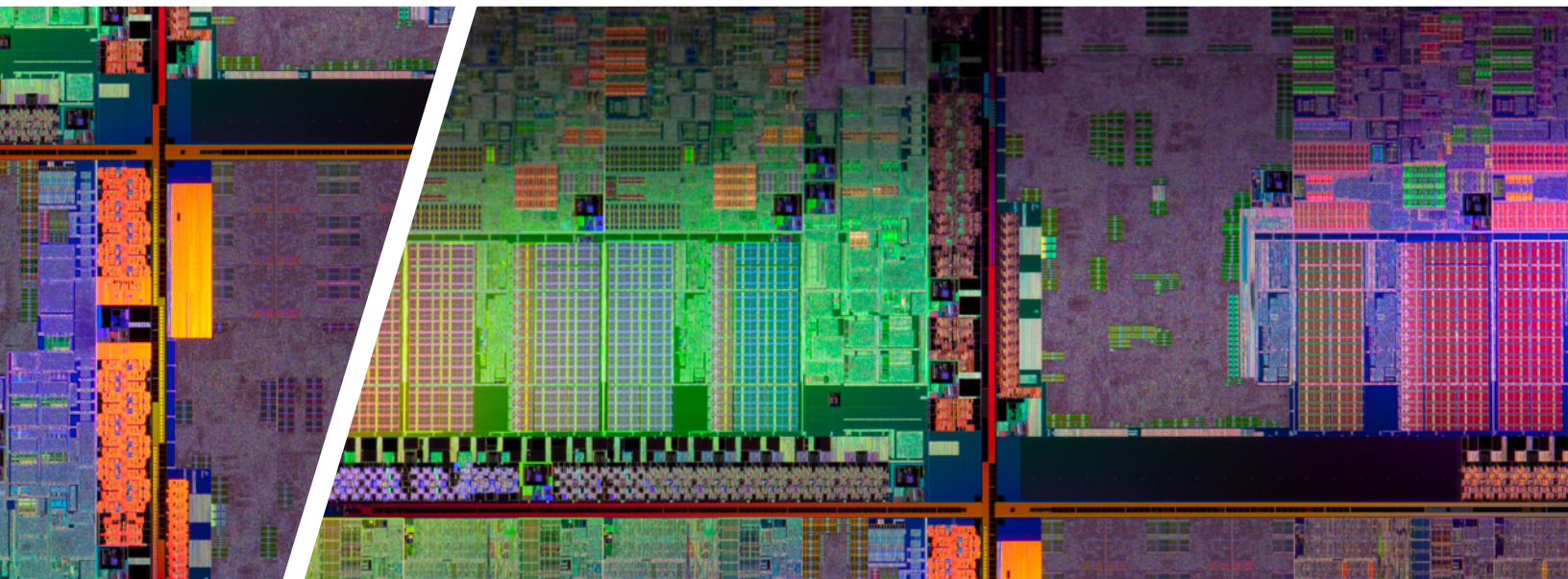
All video memory on processor graphics and earlier generations of Intel® integrated graphics (including Intel® Graphics Media Accelerator Series 3 and 4) use Dynamic Video Memory Technology (DVMT). DVMT memory is considered "local memory." "Non-local video memory" will show as ZERO (0). This should not be used to determine compatibility with Accelerated Graphics Port (AGP) or PCI Express®.

To accurately detect the amount of memory available, you'll need to check the total video memory availability. The Microsoft DirectX SDK (June 2010) includes the VideoMemory sample code and describes five commonly used methods to detect the total amount of video memory. Applications targeting Microsoft Windows Vista® and Microsoft Windows® 7 should reference `GetVideoMemoryViaDXGI`. For Microsoft Windows XP applications, `GetVideoMemoryViaWMI` is a good starting place. For more information, see [the Microsoft sample code site](#).

¹ <http://blogs.amd.com/developer/2009/05/06/striking-a-balance/>



This processor is Intel's first new microarchitecture utilizing 32nm technology. Its smaller transistors and new architectural design result in higher performance at lower power.



The best place to get started with Intel® processor graphics is to check out the [Intel Graphics Developer's Guide](#). This guide focuses on the 2nd Generation Intel Core processor family, but you'll find useful information covering all Intel® graphics.

Processor graphics excels at more than just 3D graphics and includes hardware dedicated to accelerating media processing. The easiest way to utilize this hardware is with [the Intel® Media SDK](#).

The Intel Media SDK has functions to streamline and simplify video encoding, decoding, and preprocessing operations. Support is provided for encoding (including H.264 and MPEG-2 formats) and decoding (including H.264, MPEG-2, and VC-1

formats). The Intel Media SDK has software fallbacks for any missing hardware acceleration, helping make it platform-agnostic. Platforms that lack hardware acceleration still utilize the optimized (and threaded) software-based video encoding and decoding.

With nearly a million PCs shipped each day, the available market for processor graphics is growing quickly. It's worthwhile to understand and validate on processor graphics. Soon, processor graphics will be everywhere. ■

ABOUT THE AUTHOR

Orion Granatir works as a senior software engineer in Intel's Visual Computing Software Development team, which is just a fancy way of saying "Orion works on video games at Intel." Most of his current work focuses on optimizing for the latest Intel® technology, including Intel® Streaming SIMD Extensions, Intel® Advanced Vector Extensions, multi-threading, and processor graphics. While in this role Orion has presented at Game Developers Conference (GDC) 2008, Gamefest 2008, GDC Online 2008, GDC 2009, GDC 2010, and the Intel Developer Forum. Orion also writes a column that is published on Gamasutra.com.



Prior to joining Intel, Orion worked on several Sony PlayStation® 3 titles as a senior programmer with Insomniac Games. The game titles he has worked on include Resistance®: Fall of Man and Ratchet and Clank Future®: Tools of Destruction.

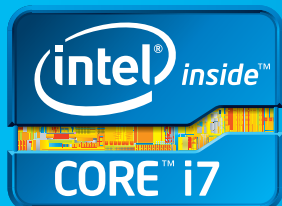


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EXPERT PERSPECTIVE:

DOUGLAS SPOTTED EAGLE

For Douglas Spotted Eagle, life knows no boundaries other than the ones that aren't faced head on. He's been able to meld his passions for music, video, and skydiving into a multifaceted career. As a preeminent Native American flute player, he's won Grammy Awards, and as a commercial skydiver and video producer, his work has been seen on Discovery Channel, Food Network, and HDNet. His expertise as a renowned educator has led to speaking engagements at countless professional conferences and events.

For most, any one of those vocations would be enough to occupy a lifetime. For Spotted Eagle, marrying his interests seemed natural. "In the technical world I live in, it's always about speed," he explained. "Everything's about being faster. Faster rendering times. Faster creativity. That theme seems to lend itself to jumping out of airplanes, making music, and producing videos."

Video Production at 300 mph

"Camera flying and aerial cinematography are highly specialized skills that are not on every camera operator's résumé," Spotted Eagle said. "What's exciting is that I can take a skydiving video project from planning through completion—write, score, shoot, edit, and deliver it using a file-based production workflow. What makes that possible is computing horsepower, RAM, and software that's finely tuned to deliver incredible performance."

Sony Vegas* Pro is Spotted Eagle's nonlinear editing (NLE) software of choice. Vegas is a native 64-bit application that features real-time multitrack video and audio editing, resolution-independent time lines, complex effects and compositing tools, 24-bit/192 kHz audio support, VST and Microsoft DirectX* plug-in support, and Dolby* Digital surround sound mixing.

camcorders for most of my aerial work now. They're ultra-lightweight AVCHD camcorders that are just the bomb."

Camera flying—the art of shooting videos of other skydivers—usually involves a single helmet-mounted camera. Commercial aerial cinematography takes that concept to a different level. Spotted Eagle's helmet can hold up to four cameras. He typically mounts

"you can't work with the original file. It needs to be converted to an intermediate, lower-resolution codec like CineForm or Apple ProRes. That conversion takes time. Vegas lets me work natively with all this different format content. In fact, if you look at my system, you'll see a CompactFlash* card, a Memory Stick PRO Duo*, and an SD card in the same reader. In many cases, I'm editing directly off the

"I'm excited about the 2nd Generation Intel Core processor . . . I see it doing some pretty incredible things for both the audio and the video production world."

— Douglas Spotted Eagle

"We run Vegas on a couple different Intel® dual- and quad-core processor-based workstations," Spotted Eagle said, "but curiously enough, I just bought a new Apple MacBook* Pro with an Intel® Core™ i7 processor Extreme Edition. Using Boot Camp*, I'm able to run Vegas under Windows* 7. With the horsepower of the [Intel®] Core™ i7 processor and a full complement of RAM, I'm able to work with time-lapse footage shot with a Canon [EOS*] 5D Mark II DSLR at full frame rate, full 5K resolution directly off the memory card from the camera. There's no time lost transferring footage from the camera to the computer."

Spotted Eagle's choice of camera depends on the nature of the project. "I shoot a lot with the Sony PMW-EX1 on the air and on the ground," he said. "I just started experimenting with Sony Alpha-NEX* DSLR cameras. They're nice small form-factor cameras."

Spotted Eagle's VASST—Video Audio Software Support Training—production team also uses Sony professional video cameras that shoot XDCAM* and XDCAM HD format footage. "They're great for both ground and aerial shoots for commercial work, but we reserve them for higher-budget projects," he said. "It's fair to say that we've transitioned to mid-size and smaller camcorders. I use Sony CX*-series

four, but sometimes mixes it up by using two video cameras and a single DSLR camera. But he doesn't stop there.

"I jump with a Canon 7D that can be used as either a still or motion video camera," Spotted Eagle explained. "And I'll mount two Sony CX100s on the sides—one forward-facing, the other rear-facing. Sometimes I'll add a GoPro*, which is a small AVC camera, to each wrist, on my chest, or on a toe. Other times, I'll put one on the parachute itself to get an inside view. People might think a [USD] 300 camera has no place in a professional shoot, but they offer better quality than what we were shooting with DV-format cameras 10 years ago."

Shooting with a variety of cameras means wrangling a variety of HD video formats and frame rates. Vegas enables Spotted Eagle to work with all that mixed-format footage on a single time line. More important, with its native format support Spotted Eagle can enjoy the full benefits of a file-based workflow. As he put it, "One of the benefits to file-based workflows is that you no longer have capture time. Capture time in linear, tape-based workflows was one-to-one. If you had an hour of content, it took an hour to capture from tape.

"With NLEs that don't offer native format support," Spotted Eagle continued,

cards. I don't even have to transfer the files to my computer's hard drive."

Spotted Eagle uses memory cards to shuffle dailies. "It's a huge time-saver," he explained. "When you come off a shoot and want to review what you've just done on a big screen, you just throw the memory card into a reader and pop open Vegas. You don't even have to throw the video onto a time line. Vegas just plays it out over HDMI or over HD-SDI."

Storage: Fast and Faster

Fast, affordable digital storage plays a key role in high-performance video production. HD files, after all, consume hard disk space fast. Most productions typically rely on 7,200 rpm or faster SATA drives or striped RAID arrays to maximize performance. Spotted Eagle, however, has recently discovered the benefits of Intel® Solid State Drives (SSDs). He explained, "I've got a solid-state boot drive on my main editing system in my production trailer. It lets you get to things instantly." Because SSDs have no moving parts, there's no waiting for a mechanical seek-head. When used as boot drives, operating systems initialize faster, applications launch right away, and projects typically load in seconds, not minutes. "SSDs work really well for editing," he added. "And they're so fast for editing images in Adobe Photoshop*."



Sounding Off

Cakewalk SONAR* is Spotted Eagle's go-to digital audio workstation (DAW). SONAR takes advantage of 64-bit systems and comes with a full range of virtual instruments, mixing tools, and mastering effects. He augments SONAR with various third-party plug-ins and external hardware—two areas where Spotted Eagle sees room for improvement.

"On the audio side of things we rely so much on the external hardware and some things become really funky," he said. "I have a number of high-end audio DSP [digital signal processing] cards that accelerate various effects plug-ins like reverb and

compressor/limiters. Those cards aren't 64-bit compatible. That suddenly puts the onus back on the DAW. When I'm running multiple channels of audio and playing softsynths at the same time, latency becomes a problem. The last thing you want when you're playing a lead line or chords is for there to be a delay of even a few milliseconds between what you play and when you hear it. And with chords, you don't want to have notes dropping out because you're taxing your system."

Spotted Eagle longs for the day when, as he put it, "computers have an input jack that connects to really high-quality DACs, so all we'll need is a high-end microphone. No other external hardware. No accelerators. No third-party anything. I know that day is coming."

VASST Training

When he's not jumping out of airplanes, producing video, or composing music, Spotted Eagle devotes his time to helping educate users. He frequently tours doing training for Adobe, Apple, and Sony Media Software. In addition, he publishes instructional books and DVDs under the VASST label for the Sundance Media Group.

"It's unfortunate that there are so many misconceptions out there," Spotted Eagle said. "People read about the latest innovations—for example, 24-bit, 192-kHz sampling—and don't realize that there's more to gaining an advantage

from using them than just buying one piece of gear. You have to fine-tune your entire system. If you're using low-end, noisy mics with high-definition audio hardware, you're going to be recording really high-quality noise."

Spotted Eagle also feels people need a better understanding of video and audio codecs, another aspect of production. To that end, VASST just completed a training DVD on digital cinematography. "A lot of it deals with the AVC [Advanced Video Coding] codec—how it works, what you need to be aware of, and so on," he said. "VASST is a big part of what we do, and it's grown tremendously."

Fast Forward to the Future

VASST also develops plug-ins for Vegas Pro. "One of them, Mayhem," he said, "applies a filter to titles and grunges them up by slicing out individual frames and either randomly placing them inside of an in-and-out point, or you can deliberately place them inside an in-and-out point. It can create some very unique looks."

Scatter Shot gives Vegas users access to a user-friendly 3D engine. Spotted Eagle elaborated, "Vegas has a very good 3D engine of its own, but it requires users to enter data by the numbers. Scatter Shot gives users an interface that lets them use 3D in Vegas without doing math."

Spotted Eagle stays on top of new technologies, maintaining a working relationship with engineers at various hardware and software companies, including Intel. One emerging technology he's particularly interested in is Intel's 2nd Generation Intel® Core™ processor.

"I'm excited about the 2nd Generation Intel Core processor," Spotted Eagle told us. "It originally looked like the processor was designed to accelerate the gaming experience. I see it doing some pretty incredible things for both the audio and the video production world." ■

Intel® Media SDK: Tapping into Accelerated Hardware and Software Performance

Successful consumer video-editing and playback applications shield the user from seeing just how much advanced computing is going on under the hood. Modern HD codecs such as VC-1 and H.264 take a lot of processing power to encode, decode, and play back smoothly, as well as edit and enhance with complex transitions, special effects, and titles. But to achieve transparent performance while providing the ability to handle modern HD video formats and codecs, developers must optimize and fine-tune their applications for a plethora of platforms.

Typically, that kind of work is inordinately time-consuming. Developers must have a deep understanding of the complexities of multiple graphics platform architectures and produce different code paths to support each one.

The Intel® Media Software Development Kit (Intel® Media SDK) offers developers a single, unified solution for handling video pre-processing, encoding, decoding, and transcoding. With support for current and future Intel® HD Graphics processing components, the Intel Media SDK's API enables developers to optimize their code for both hardware and software-only acceleration, as well as third-party graphics hardware and codecs.

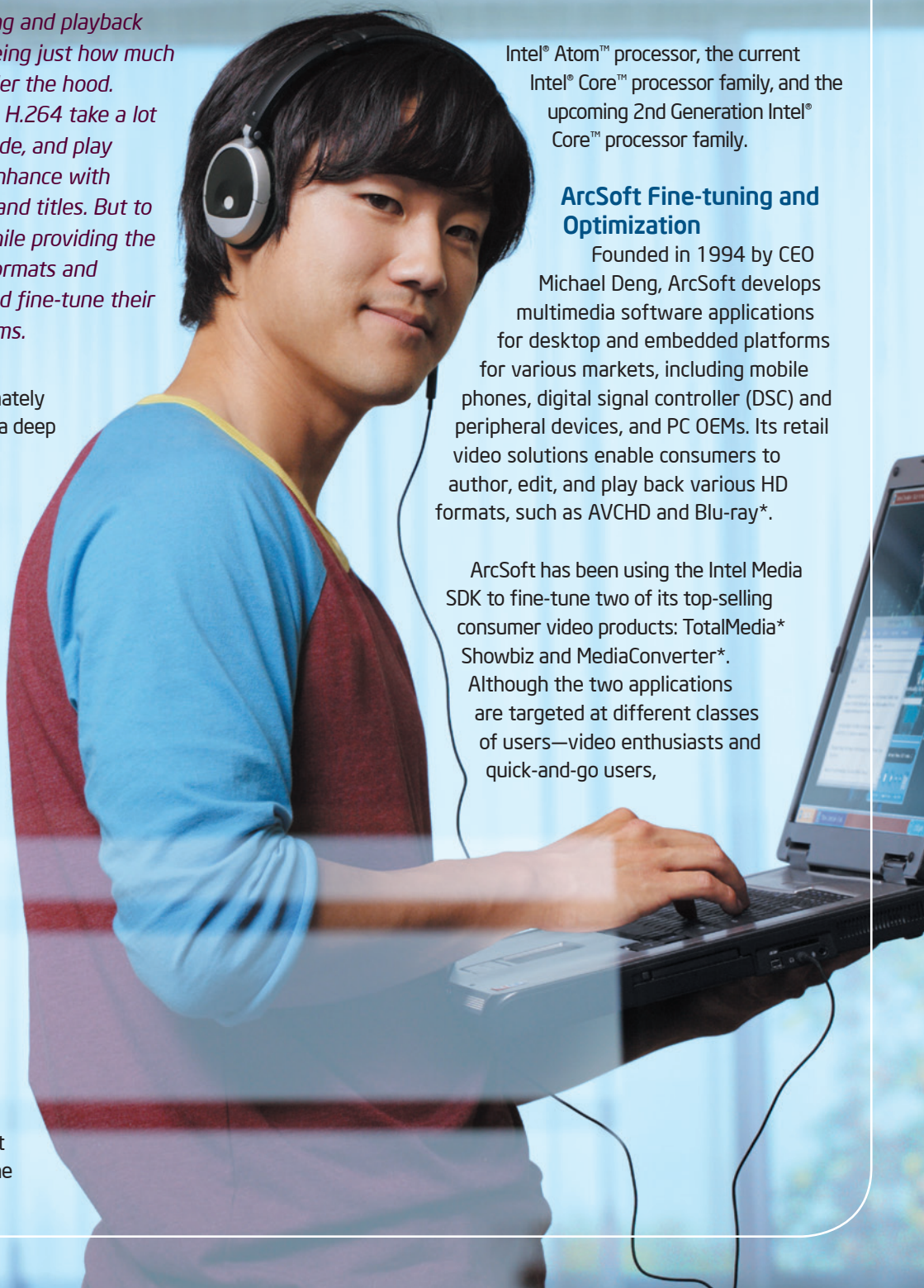
ArcSoft is one of a number of leading software developers that has been using the Intel Media SDK to optimize their video playback and editing applications, helping it develop easy-to-use, highly scalable products that run on a range of processors, including the

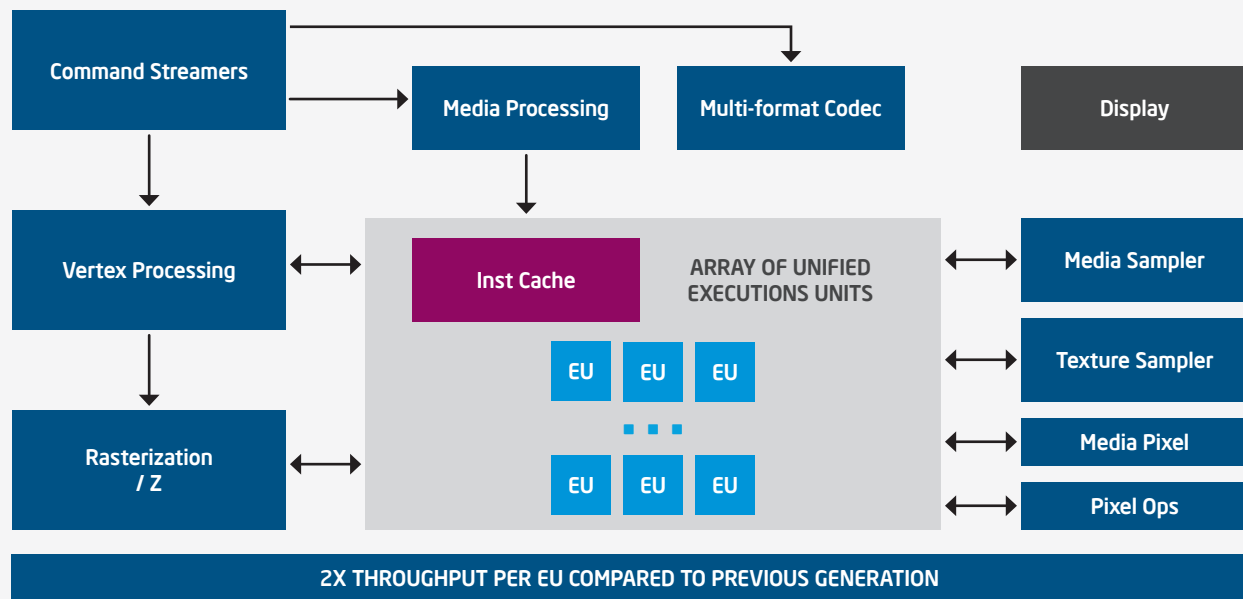
Intel® Atom™ processor, the current Intel® Core™ processor family, and the upcoming 2nd Generation Intel® Core™ processor family.

ArcSoft Fine-tuning and Optimization

Founded in 1994 by CEO Michael Deng, ArcSoft develops multimedia software applications for desktop and embedded platforms for various markets, including mobile phones, digital signal controller (DSC) and peripheral devices, and PC OEMs. Its retail video solutions enable consumers to author, edit, and play back various HD formats, such as AVCHD and Blu-ray*.

ArcSoft has been using the Intel Media SDK to fine-tune two of its top-selling consumer video products: TotalMedia* Showbiz and MediaConverter*. Although the two applications are targeted at different classes of users—video enthusiasts and quick-and-go users,





2nd Generation Intel® Core™ Processor Graphics

Integration

Next Generation EU

- Now designed into the same die as CPU
 - Leading-edge 32nm process
- Shared last-level cache
 - Configurable cache partitioning
 - Higher bandwidth for graphics
 - Lower latency
 - Reduced DRAM accesses
- Utilize CPU power management
 - Improved graphics power efficiency
 - Best overall (CPU+Graphics) power decisions

Performance Optimizations

Next Generation EU

- Larger registration file for increased parallelism and efficient complex shader execution
- 2nd generation parallel branch for efficient parallelization in the face of deeply nested conditionals
- New transcendental math capability for 4x-20x more throughput
- New instructions for reach 1-to-1 with API ISA (CISC) and higher throughput at same clock rate

High-level block diagram of 2nd Generation Intel® Core™ processor parallelization and integration.

respectively—each is optimized to take advantage of Intel® multi-core, multi-threaded processor technology.

The MediaConverter utility transcodes multimedia files into formats optimized for use on mobile phones, portable media players, TV, and other popular devices. With a single click, users can download, convert, and transfer videos to an Apple iPod*, iPhone* 4, iPad*, a Sony PSP*, an HTC Evo* 4G and other Android phones, Nokia and BlackBerry phones, and more.

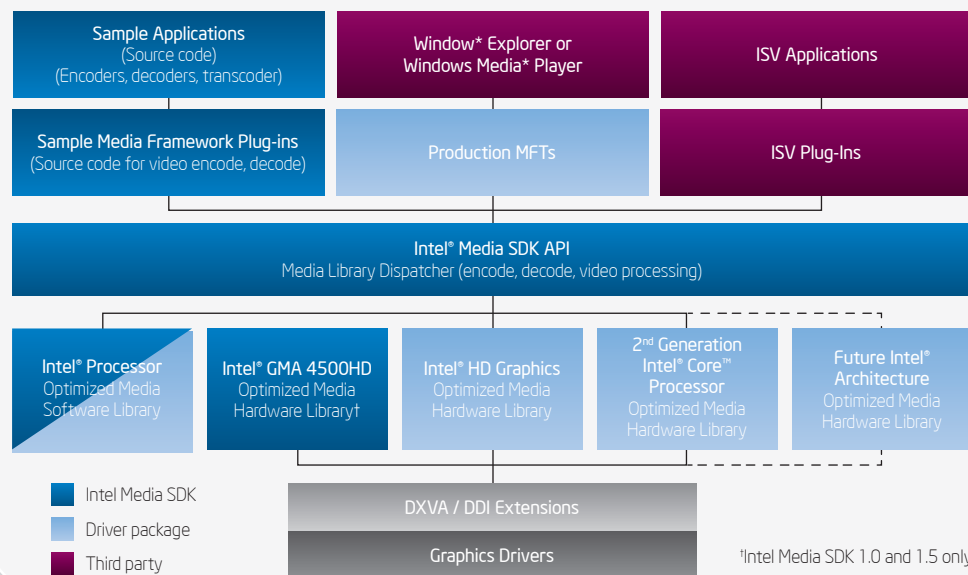
Intel Media SDK helps streamline the development process with an easy-to-use API interface that simplifies encode, decode, and transcode build processes as well as pre-processing functions. The libraries and samples included in the Intel Media SDK help accelerate the process of optimizing code for individual target platforms, using built-in performance capabilities. For example, if a target device is capable of hardware acceleration, the Intel Media SDK automatically utilizes it to deliver the full

performance benefits of that component for encode and decode operations. Future Intel® platforms will support these same capabilities. In addition, Intel Media SDK 2.0 allows developers to take advantage of Intel® Quick Sync Video, which allows encoding to be handled directly by specialized hardware in the 2nd Generation Intel Core processor platform.

"Developing transcoding and encoding used to be a very complicated process. Thanks to the simplicity of the APIs in the Intel Media SDK for both VPP (video pre-processing) and encoding, our development time was shortened," said George Tang, vice president and general manager of Video Home Entertainment. "Intel's multi-core, multi-threaded processor technology significantly reduces the conversion time in our most recent version of MediaConverter. The user can now convert four or more files concurrently while leaving the processor free for other tasks."

An API Tuned for Maximum Performance

The video encoder and decoder algorithms that form the heart of the Intel® Media SDK originated from Intel® Performance Primitives. They have been refined and improved to a high degree of efficiency, and tuned for maximum performance on next-generation Intel® platforms. This refinement process has resulted in a very easy-to-use, versatile API that can serve as a standard interface for coding to a wide range of hardware platforms. The versatility is evident in the open architecture approach that allows companies to extend the API beyond Intel-based graphics chipsets and architectures to support any number of third-party graphics hardware solutions or software codecs.



A high-level overview of the Intel® Media SDK architecture.

TotalMedia ShowBiz provides video- and photo-editing tools for enthusiasts to fine-tune their personal content. SD and HD video footage can be combined with stills, music, titles, and transition effects. Finished videos can be easily transferred to various playback platforms, including iPhone, iPod, Apple TV*, Sony PSP, and Microsoft Xbox 360*, as well as uploaded to YouTube*.

New Processor, Enhanced Capabilities

The 2nd Generation Intel Core processor combines CPU and graphics processing functionality with deep parallelism in a single 32nm chip. Because the Intel Media SDK supports the 2nd Generation Intel Core processor, ArcSoft applications can readily take advantage of the processor's capabilities.

"Intel® Media SDK is a very rich, intuitive toolkit that provides well-defined media APIs to enable media transcoding capability... [it] detects the underlying hardware's capabilities and intelligently utilizes CPU and graphic abilities and resources. It makes our programming very simple and runs great on different Intel® platforms."

- GEORGE TANG, VICE PRESIDENT AND GENERAL MANAGER, VIDEO HOME ENTERTAINMENT GROUP, ARCISOFT

a great way to parallelize the decode/encode sessions that are essential to video-editing applications. Our products, optimized for the next generation Intel® architecture, will enhance our users' video-editing experience.

"Using Intel's Media SDK was an enormous help. Not only did the encoding process greatly improve, but it actually transformed the way a traditional transcoding application behaves. With the excellent performance introduced by Intel Media SDK and the next generation Intel architecture, the user doesn't need to wait any longer. When converting media files, there's plenty of processing power to work on other tasks."

ArcSoft has several flagship products coming out, including TotalMedia Theatre, its best-selling Blu-ray and [stereoscopic] 3D playback application. "Of course, it is optimized for the latest Intel platform with Blu-ray 3D support," Tang said. "Similarly, our MediaConverter and Panorama Maker* (coming soon) also have focused on and covered [stereoscopic] 3D creation and take full advantage of the capabilities of the 2nd Generation Intel Core processor."

Future-proofing Made Simple

Another very popular application for home video enthusiasts is Media Player Classic Home Cinema (MPC-HC). MPC-HC is an open-source, small-footprint media player for Microsoft Windows* that resembles Windows Media* Player v6.4, but includes a lot more up-to-date features. Media Player Classic supports a wide range of audio and video codecs, including H.264 and VC-1 with DxVA support for third-party graphics hardware-accelerated decoding. Media Player Classic even supports Adobe Flash* FLV and SWF files and can make use of Apple QuickTime* and RealNetworks RealPlayer* architectures.

Eric Sardella, a senior software engineer in the Intel® Software and Services Group, has been collaborating on a project to enhance Media Player Classic Home Cinema, including a way to alleviate the complexities of working with Microsoft DirectX* Video Acceleration (DxVA). Using the Intel Media SDK enabled him to quickly optimize encode and decode for hardware acceleration

that takes full advantage of Intel® processors as well as third-party graphics hardware acceleration.

As Sardella put it, “DxVA is hard, and sometimes it takes a lot of trial and error putting video in a player. Microsoft’s documentation is very difficult to decipher, and there’s precious little sample code available. To make matters even more difficult, Intel hardware has specific implementation rules that are not very well known.”

Sardella has experienced the benefits of Intel Media SDK’s evolution first hand. When he first started working on the Media Player Classic project, Intel Media SDK was in its infancy. Over time, Sardella has used each successive version of Intel Media SDK to add native hardware acceleration support for various codecs, including VC-1 and MPEG-2.

“With 1.0 and 1.5, developers had to download the SDK and a vendor would have to package the DLLs manually for any new drivers that were required to run a new piece of hardware. That wasn’t ideal for forward-compatibility,” Sardella said. “With 2.0, [Intel] Media SDK updates itself. When the graphics driver is installed it updates the hardware DLLs automatically.

“So if a brand new platform comes to market after you’ve written your code, the platform will automatically have the DLL packaged with it. Any application written with the Intel Media SDK will automatically take advantage of new hardware,” he continued. “Or if the ISV releases a patch for bug fixes, they can just tell the user to update their graphics driver and the Media SDK DLL will come along with it.”

For the open source Media Player Classic project, this capability overcame a

stumbling block—previously, an application couldn’t check for a DLL on SourceForge.net, the open source applications and software directory. Sardella elaborated, “Now my application can check and see if the DLL is present on the system. It can tell if the graphics driver installed it. So if it’s there, my application can use it.”

The open source nature of the Media Player Classic project presented unique challenges, but it has given Sardella ample means to put the Intel Media SDK through its paces. “People work on this when they’re finished with their day job, so some new features are implemented really quickly, while others take a very long time to get approved,” Sardella explained. “But the simple interface of the [Intel] Media SDK lets me get things done in a week that I would’ve struggled with for much longer.” ■

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TALKING TECH TACTICS WITH *FOOTBALL MANAGER** 2011

by John Tyrrell

Visual Adrenaline sucked on a half-time orange with Sports Interactive, the London-based developer of the multi-million-selling PC simulation series *Football Manager**, and talked multi-thread optimization, integrated graphics, and just a little bit of football.

Kick Off

Second only to the terraces surrounding the hallowed turf of the nation's football grounds, the pub is the next most popular choice of natural environment for the British football fan. So it's fitting that the offices of Sports Interactive Ltd, the creators of the world's foremost and multi-million-selling football (soccer) management simulation series, should be located right on top of just such a drinking establishment. With its big screen match coverage and solid draught beer selection, The William Blake pub on Old Street in central London, UK has doubtless born witness to many impassioned discussions about football, and probably just as many again about the game's virtual progeny, the revered *Football Manager* game series, which for many years has been crafted with love and passion in the offices directly above it.

Football Manager is a game that allows players to step into the shoes of the be-suited leaders of beloved teams around the globe and strive for championship victory in any one of 50 major leagues from Hong Kong to Chile, not forgetting football's European heartland of course. Players manage their chosen team, buy and sell players, interact with the press, and plan tactics, all with the ultimate goal of topping the league and filling the boardroom trophy cabinet at the end of the season. The game's 3D match engine lets players watch every match in real-time, taking the game far beyond its previous 2D top-down presentation toward something ever closer to the real thing.

The series has come a long way since its genesis in the imaginations of Paul and Oliver Collyer, two young British football fanatics. In the words of Sports Interactive Senior Producer Grant Appleyard, the brothers' only aim was "to make a game that they could enjoy themselves." Working from their Shropshire bedroom, the pair

released the first *Championship Manager** in 1992, a simulation game written in BASIC, a language more commonly associated with school classrooms than high-performance PC software.

From this acorn grew the mighty *Championship Manager* franchise. At its peak, every subsequent release in the series became the fastest selling PC game ever in the UK. Following a switch of publisher from Eidos Interactive to SEGA in 2004 and a name change to *Football Manager* for all subsequent games from Sports Interactive, the team has continued its domination of the genre unabated, with its latest iteration *Football Manager 2011* making its appearance in November 2010 for the PC, joined by *Football Manager Handheld** 2011 for the Sony PlayStation* Portable, the Apple iPhone*, and the Apple iPod touch*. Taking Sports Interactive's vision of "the beautiful game" online, SEGA also released the MMO management sim *Football Manager Live** in 2008.

Today, Paul and Oliver Collyer are far from being ivory tower moguls, with both brothers still rolling up their sleeves and



getting elbow deep in code. Paul is the match engine programmer, while Oliver, or Ov as he's known to the team, is the lead programmer on *Football Manager Live*. Staff turnover is low, passions are high, and the tightly knit team is forever pushing the series forward, embracing the endless tide of new and improving PC technologies to move inexorably toward their vision of the perfect football management simulation.

Match Fit

This is not a series that rests on its laurels, even if its passionate and vocal fan base was prepared to let it (which they're not). The last 20 years have been one long, iterative process—a process that shows no signs of ending any time soon. "If you look at the features that we've added this year, it's something like 450," said Appleyard.

The majority of new features in the game come from the development team itself and are proposed, discussed, and, if they pass muster, implemented in-game through a highly democratic process that involves everyone. Sports Interactive maintains an open database that allows any member of the team to suggest improvements or new additions to the already impressive array of in-game functionality.

One of the important new features to make it through the process and into *Football Manager 2011* is the live Contract Negotiation system. Agents have become a permanent fixture of the footballing world, game players can enter

into complex negotiations with different virtual agents to master the minutia of contractual clauses and secure their next big signing.

However, when your fan community is as big and vocal as *Football Manager's*, the end-users themselves are bound to make countless requests for features. But while requests are plentiful, nothing gets through without the Sports Interactive stamp on it. "We listen to our users and we try to put things in they want, but we'll always give it the Sports Interactive twist. We'll discuss it, thrash it out, plan it, and design it properly here," explained Appleyard.

One such feature that fans have been clamoring for is Dynamic League Reputation, a system which, over extended periods of playing time, allows players who build strong teams to positively affect the reputation of the league they're playing in, ultimately letting them attract star players from elsewhere and bringing a new long-term dimension to the gameplay.

As Appleyard pointed out, the introduction of Dynamic League Reputation is "a good example of a feature that shows the length of time people play the game, because dynamic league reputations can't really kick in until 10 to 15 seasons into the game." With over 400,000 registered users on the game's official forums alone,

you don't have to look far for evidence of this fan fervor and commitment.

Set Piece

Football Manager is a PC game for which multi-core processing is a massive advantage. The game's match simulator re-creates vast numbers of football matches based on countless variables, with each game requiring its own independent process, demanding that every pass, foul, and goal be calculated for a field of 22 men over 60 minutes.

"We have users that will play the game over a long period of time, and that's when optimizations that speed up the game generally come into their own because they're not sitting looking at the progress bar," explained Appleyard.

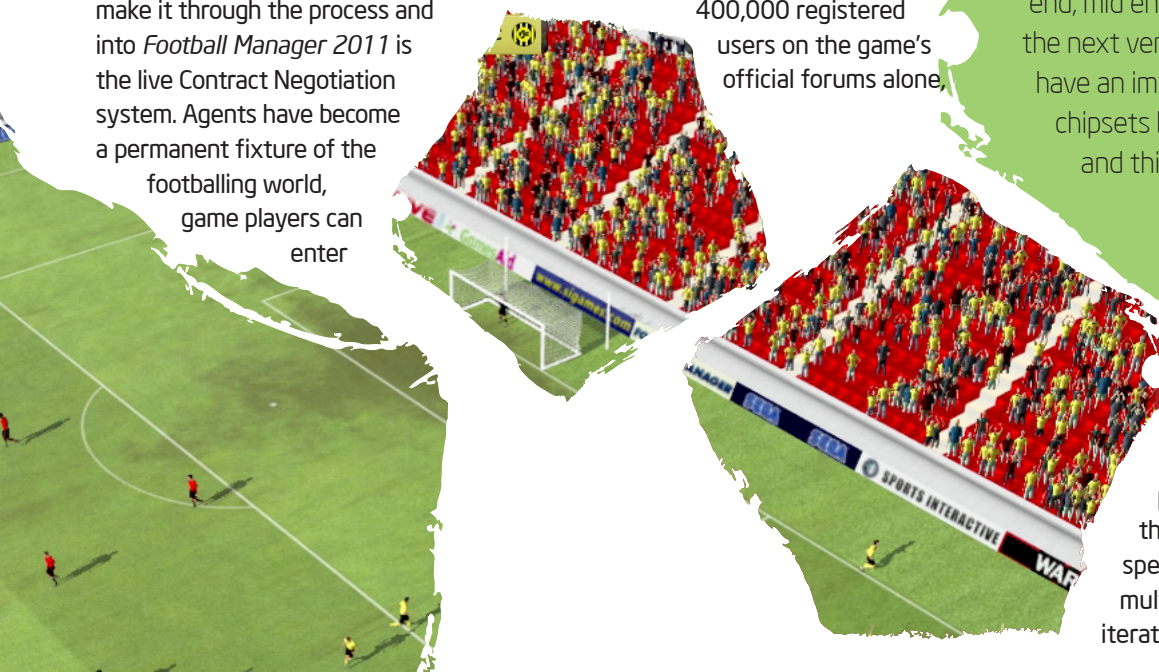
"If they're playing an unglamorous lower league team they probably just want to get through the match quickly, but the game still has to compute the match events."

"We now have the use of this [Intel® Graphics Performance Analyzers] suite of tools across the whole range of Intel target platforms.

We can keep running analysis over the lower end, mid end, high end, and in a year's time with the next version of *Football Manager* I think we'll have an improved performance across all Intel® chipsets because of the use of these tools and this extra information that we can now gather."

— GRANT APPELYARD, SENIOR PRODUCER, SPORTS INTERACTIVE

Such a heavy drain on the CPU can be substantially alleviated by optimizing parallel processing through multi-threading. Sports Interactive has spent many years improving the multi-core optimization in successive iterations of the game, the ultimate goal





being to deliver the fastest player experience with the least waiting around.

"You get to Saturday, it's a big three p.m. kickoff, and all of the leagues are playing their games. The better the game utilizes multi-core CPUs to play separate matches on each core means the less time the computation takes," said Appleyard.

Optimizing the multi-core performance of *Football Manager* is important to Sports Interactive in a PC market where not every title does so as effectively. "Sometimes you find with games that even if you have, say, a quad-core machine it will only use two cores," noted Appleyard, "whereas with our game, the more cores that you add the faster it becomes because it knows how to use those cores in the most efficient manner."

To take a closer look at the scaling that Sports Interactive has achieved with *Football Manager 2011*, Intel software engineer Steve Hughes spent time with the team to run a series of tests using a six-core, 12-thread Intel® Core™ i7 980X processor (formerly code-named Gulftown) machine. The results of the testing showed that the game ran significantly faster comparing identical frequency six-core to four-core systems. Even more impressive was the result comparing two- and four-core systems, where the speed almost doubled.

The boost from two to four cores is especially significant to Appleyard: "If you look at the market and how many people have those sorts of machines, that's the bulk there, so to have that kind of scaling in the key area of the bell curve is great."

One of the main tests the team runs during development is heavy "soak" testing where the game is set on Holiday mode and left to automatically progress through the season. It's a serious test for any processor, and as Appleyard noted, "the fastest performance that I've seen so far was on the Intel machines that we received," a result that reflects as much on the achievements of the development team as it does on the hardware itself.

The optimization of speed performance using multi-threading is a key factor in delivering the best possible end-user game experience, and as Hughes noted, "although *Football Manager* is pretty unique in that it is obviously parallelizable, nevertheless Sports Interactive is showing us the way forward by utilizing the full power of multi-core systems."

The 3D match engine is a relatively new addition to the *Football Manager* series, making its debut in November 2008 in the *Football Manager 2009* game. The engine lets the user watch entire matches re-created in full 3D with the objective of immersing players in a live match-like experience. Many changes to the engine have been introduced in *Football Manager 2011*, including improved crowd simulation, completely new player models, and a TV camera, which brings the experience closer to watching a real match on television.

As with multi-threading, ensuring it squeezes the optimum performance for the GPU-hungry processes involved in recreating the 3D experience is something that Sports Interactive has long made a priority. Key to the success of *Football Manager* is that it doesn't demand the latest hardware to deliver a great user experience. The graphics engine is optimized to run even on older processors, as Hughes noted after running the game on an old 945 chipset and testing it using the Intel® Graphics Performance Analyzers (Intel® GPA) tools.

Even on a machine that is at the lower end of the minimum spec requirements, the code put in a solid performance, though some minor issues were identified. Referring to the performance of the 945, Appleyard admitted, "It wasn't brilliant, but we already knew that, and the tools are something that we can use going forward."

Using the Intel GPA tools allowed the team to identify a graphical issue where over-large crowd textures were hampering performance. After identifying the problem, they were able to apply mip-mapping to optimize the graphical textures, resulting in an overall performance boost for the match engine.

"We now have the use of this suite of tools across the whole range of Intel target platforms," continued Appleyard. "We can keep running analysis over the lower end, mid end, high end, and in a year's time with the next version of *Football Manager* I think we'll have an improved performance across all Intel® chipsets because of the use of these tools and this extra information that we can now gather."

Moving from the past toward the future, when Appleyard first saw the 2nd Generation Intel® Core™ processor-based machine with GT2 onboard integrated graphics that was delivered to their offices, he wasn't quite sure what to make of its array of LEDs, until Hughes explained that it was designed with laptops in mind as well as desktop machines.

The match engine effortlessly achieved, and even exceeded, the target frame rate of 30 frames per second on medium settings on the 2nd Generation Intel Core processor's integrated chipset, and in the words of Appleyard, "to know that this chipset is actually going to be in a laptop and yet seeing the performance that we got with it is very impressive."

"The old laptops were always considered to be inferior machines," continued Appleyard. "If you talked to someone 10 years ago about integrated onboard graphics, immediately it was, 'oh, here we go, it's going to really chug along.' But that's not the case at all anymore."

It's something that bodes well for the growing legions of fans that play the games on laptops. "We still do have guys that sit at their desktops and have the real high-end stuff," said Appleyard, "but if you look at the middle, a lot of them are running on laptops nowadays, so this improved architecture can only be a good thing."

All to Play For

Ten years into his tenure at Sports Interactive, Appleyard remains boundlessly enthusiastic about *Football Manager*, seeing no end to the annual rounds of improvements and iterations. "There's always extra stuff to put in. We're already gearing up for *Football Manager 2012* and starting to think about features we can put into that. It comes from having that open database. Any idea that anyone thinks of goes in there. We've got literally hundreds of ideas that are planned for later games."

Appleyard is very clear on the overall direction of the series. "Looking forward we'd want to improve the realism of the whole match experience. That's the holy grail for simulation programmers and developers."

Like his compatriots at Sports Interactive, Appleyard is never happier than when he's talking football. So who does he support? "I grew up in the North East so Newcastle United is my team. Although I moved out of there when I was 18 you never leave it.

Especially up there, football's in the blood. Bleed black and white and all that, and you never change really. Can you hear my accent coming out there?"

Football's definitely in the blood at Sports Interactive, and it may well be in the water, the beer, and more besides. The team skillfully channels its life's passion through cutting-edge technology to deliver an unmatched experience to millions of fans around the globe. Fans who would no doubt be the first to say, to paraphrase the British football pundits, they got the result they were looking for. ■

ABOUT THE AUTHOR

John Tyrrell's career in the games industry began with the launch of Nintendo's Pokemon on an unsuspecting British public in 1999. After a decade of international PR campaigns, supplemented with work as a freelance writer, he left the position of Worldwide PR Director at Atari in 2009 to establish Hot Socket, a communications consultancy based in Lyon, France.

Intel's Orion Granatir Teams up with Gamasutra to offer Core Insights for Core Developers.

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ANIMATION EVOLUTION:

A BIOPIC THROUGH THE EYES OF SHREK

Four animated films starring Shrek, the world's most lovable ogre, have graced the silver screen over the last decade, each achieving significant breakthroughs in computer-generated imagery and each building upon the latest advances in processor technology.

The final film in the franchise was released in May 2010, making this a good time to consider what DreamWorks Animation has accomplished over the course of telling the Shrek saga. The studio has used every technique, tool, and processor cycle at its disposal to elevate the believability, expressiveness, and pure animated impact of the characters in this iconic film series.

Processing Power Drives Advances in Animation

One way to look at the advances in animation is through the virtual eyes of Shrek, a character first introduced by DreamWorks Animation in 2001. *Shrek* won the first Academy Award for Best Animated Feature and established DreamWorks Animation as a leader in CG animation.

Over the years and throughout the production of the *Shrek* franchise, a number of DreamWorks Animation's technological advances have been enabled by Intel® technology.

As DreamWorks Animation CTO Ed Leonard said, "We talk about render power and the visual imagery that it can provide. We talk about processing cycles as a core filmmaking aspect as much as we do storyboards and cast. To say that without processing power we wouldn't have a film is an understatement. It is among the essential elements in bringing great films to life."

Render Hours on the Rise: Shrek's Law Meets Moore's Law

Since 2001, many of the advances in producing animated films have been forged by leaps in processing power. Comparing the basic metrics of the animation process (time to render frames, availability of special effects, real-time visualization, complexity of scenes) provides a startling indication of just how far this technology has progressed in less than 10 years, as



Moore's Law, a law that postulates we can double the number of transistors on a chip every 24 months. The first microprocessor that was in that film clip [shown on-screen] was the 4004. It had a grand total of 2,251 transistors. The new processors that we're introducing at CES today have over a billion transistors."

shown in Figure 1, which charts processing power needs for *Shrek* through *Shrek Forever After*.

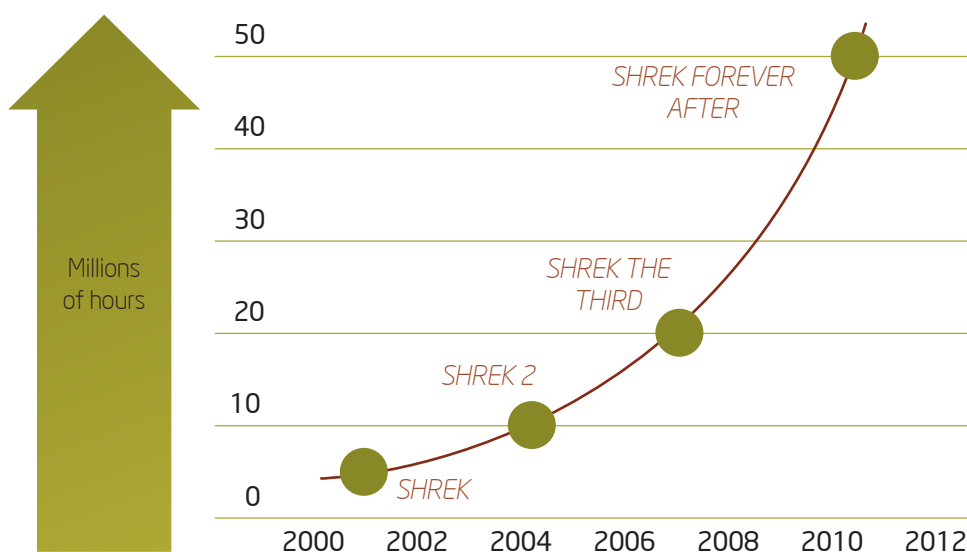
DreamWorks Animation coined "Shrek's Law," a tongue-in-cheek corollary to Moore's Law. According to Shrek's Law, the CPU render hours needed to complete production on a theatrical sequel will double compared to the amount of time needed on the previous film. This law has proven itself true on the *Shrek* movies: In 2001, *Shrek* required approximately 5 million CPU render hours. In 2004, *Shrek 2* required over 10 million CPU render hours. In 2007, *Shrek the Third* required over 20 million CPU render hours. Finally, the 2010 3D release of *Shrek Forever After* topped the charts at more than 50 million CPU render hours. All of this was achieved without significantly expanding the size of DreamWorks Animation's data center.

While delivering the keynote address at CES 2010, Paul Otellini observed, "As you know, Intel is a company built on

"What I find interesting about Moore's Law, though," Otellini continued, "is that it's not a law of nature. It's a law that reflects human inventiveness. We've been able to advance technology with consistent predictability by embracing the unpredictability of the discovery process. Every two years, we schedule a breakthrough. Each step along the way takes six years to build and costs [USD] 12 billion a step. That's an expensive proposition, but it's one that has enabled the products that have fueled the computer industry for over 30 years."

Putting Additional Processing Power to Work

At DreamWorks Animation, this geometric increase in compute power has enabled a vast range of new visual capabilities. Let's take "global illumination" as an example. As Lincoln Wallen, head of research and development at DreamWorks



"Processing power helps in terms of all the interactivity—being able to see things quickly and keep the creative flow. You don't want the artist waiting for the computer to react. You want artists to ask their computers to do something and for those things to happen as quickly as possible so that they can go on to the next thing. Waiting doesn't help the artistic process."

Derek Chan,
Head of Digital Operations,
DreamWorks Animation

Figure 1. Total render hours per movie: *Shrek* through *Shrek Forever After*



DreamWorks Animation Innovates with Cloud Computing

The future of CG rendering is definitely in the clouds. During the production of *Shrek Forever After* and *How to Train Your Dragon*, DreamWorks Animation pushed the state-of-the-art and used cloud computing to complete over five million render hours in a New Mexico-based compute facility. Addressing peak demand with a utility service model is highly scalable and cost effective.

"Our success with both

How to Train Your Dragon and *Shrek Forever After* is working

proof that high-performance computing clouds are not only possible but practical," said Ed Leonard, DreamWorks Animation's chief technology officer.

"Having the ability to instantly scale compute resources to meet the demands of our industry-leading artists is one of the holy grails in CG rendering. There is no doubt in my mind that this is the future of rendering."

This model of providing cloud computing services to deliver massive amounts of computational resources on demand promises to change the approach used in a variety of compute-intensive activities.. ■

Animation, explained, "Global illumination is the ability to have everything interact, in terms of light."

Consider a character standing next to a red wall. The wall itself is not a true light source but will reflect light that strikes its surface and create a slightly red glow. This affects the lighting on any character standing next to that wall. This kind of bounce lighting is the essential idea behind global illumination.

"Global illumination," Wallen continued, "is a very complex factor to calculate, because you have to not only cast rays of light, but also calculate the bounce and angle of those rays. It certainly has a notable impact in terms of the fullness of the color and, again, it is hard to see specifically other than if we turned it on and then turned it off, you would say, 'Oh, that really fills in a lot of the detail.' Global illumination creates a lot more ambient light."

This subtle but important visual effect wasn't technologically possible during feature film productions that preceded 2010's *Shrek Forever After*. From a processing standpoint, during production on the original *Shrek*, global illumination was too expensive computationally. In comparison, *Shrek Forever After* takes full advantage of the added realism of global illumination. Touches like this may be subtle but they cumulatively have a large

impact on the visual experience of DreamWorks Animation's films.

Simulating the Behavior of Everyday Objects

Simulating the behavior of everyday objects in our surroundings—the flow of water, the effects of wind, the movement of fabrics worn by a character—adds a substantial degree of processor-intensive work to the animation pipeline. For example, creating realistic hair on characters is a task that quickly consumes the available processing power.

"Hair is complex in terms of simulation," Wallen said. "Fiona's hair in the original *Shrek* was styled as a braid so that it could be treated as a single object. At that time, you didn't have characters with long, flowing hair in the film because from a simulation standpoint it was very costly to try to do."

By *Shrek Forever After*, processing power allowed DreamWorks Animation artists to unbraid Fiona's hair. In one scene, she takes off her helmet with the wind blowing fiercely, and her long hair flows in the wind—providing a great

creative moment that speaks to her character, one that simply couldn't have been achieved just a few years earlier.

Animators also rely on additional processing power to provide quick feedback on animated movements, to handle larger numbers of control points in animated characters, and to provide pre-visualization of various effects. As Derek Chan, head of



digital operations, said, "Processing power helps in terms of all the interactivity—being able to see things quickly and keep the creative flow. You don't want the artist waiting for the computer to react. You want artists to ask their computers to do something and for those things to happen as quickly as possible so that they can go on to the next thing. Waiting doesn't help the artistic process."

Mini-Farms Offload Tasks to Boost Responsiveness

The use of mini-farms—small clusters of multi-core processor systems—was introduced in *Shrek the Third* to offload the processing of complex tasks. It was then used more extensively in *Shrek Forever After*. Chan explained that during the production of the original *Shrek*, artists worked with a computer on their desks, typically a single machine with one or two cores. Each small change that was made, such as moving a light or posing a model, required the computer to go through a lengthy recalculation cycle before the artist could gauge whether the effect or movement worked in the scene.

"In *Shrek the Third*—and certainly in *Shrek Forever After*—instead of having one computer doing the commands, we had a mini-farm," Chan said. "The mini-farm was a set of machines, each with multiple cores, in the data center. The machines were dedicated to accelerating the work the artists were doing on the desktop. So, the scheduler would tile your shot or your image into many more tiles than there are cores and farm those jobs to the mini-farm machines for processing. Each of those machines had to compute only a tiny section and then send that result back. By giving the artists ten or twenty times the processing power at the desktop, we could significantly accelerate those tasks—which used to take hours to perform—down to minutes or seconds."

Parallelism, Chan observed, is the key to many of these performance gains. "With the mini-farm," Chan explained, "the artist makes the necessary changes, clicks 'recompute,' and, whoosh, it is back in seconds or minutes, not hours!"



The Power of a True Stereoscopic 3D Experience

Shrek Forever After is an especially noteworthy accomplishment because it was authored in stereoscopic 3D. This affected everything, not just the character design and movement, but even the backgrounds.

"A 2D matte painting doesn't work well in 3D," Chan said, "because your mind wants to see the geometry in the background from two different perspectives. This causes some challenges when you are used to using images to represent things that would then look flat in a 3D world."

Chan points out that this forces a lot more geometry to come into play. If you see a tree in the background in a stereoscopic 3D film, your mind expects to see some depth. Is that branch coming toward me? Are those leaves closer to me? Are they moving appropriately? Although this is something that most people wouldn't naturally think about, it's a very noticeable part of the stereoscopic 3D viewing experience.

Chan continued, "What we want is a viewing experience where you forget that you are seeing it in 3D, where your mind just gets used to the fact that it is seeing in 3D and it is not noticeable other than: Wow, this just feels more rich and involving and immersive."

The fairy tale doesn't have to end. DreamWorks Animation plans to release the entire series of *Shrek* films for the first time ever as a boxed set available on DVD and Blu-ray* on December 7, and in November 2011, the studio plans to release a feature film starring one of Shrek's most popular sidekicks—Puss in Boots. ■

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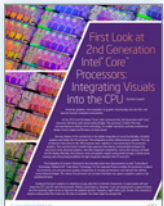
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